ELECTRICAL ENGINEERING

SEPTEMBER 1953

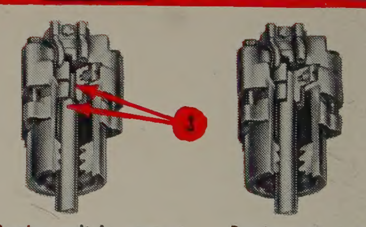
MIDDLE EASTERN DISTRICT MEETING, CHARLESTON, W. VA., SEPT. 29–OCT. 1, 1953

Three Reasons Why

...Years of Trouble-Free Service

ALLIS-CHALMERS
Indoor
OIL CIRCUIT BREAKERS

Cutaway view of DZ-60B breaker, showing one *Ruptor* unit, with bayonet-type movable contact in open position.



Ruptor unit in contact break position.

Ruptor unit in full closed position.

One — **Few moving parts!**
Bayonet contacts (1) are the only moving parts of the *Ruptor* interrupting device.

Two — **Easy inspection!**
Drop the tank, and the bayonet contacts are visible in open position. For access to the stationary contacts, one needs only to remove four bolts and cylindrical shell (2).

Three — **Self-aligning and Self-cleaning contacts!**
Tulip and bayonet contacts (3) maintain high conductivity without readjustment or cleaning. Arc energy is minimized by efficient interruption within oil-filled *Ruptor* unit. This in turn contributes to long contact life and low oil deterioration.

In addition, a mechanically trip-free solenoid operating mechanism controls contacts of time-proved *Ruptor* interrupting devices. And pole unit mechanism is self-lubricated — completely enclosed — sealed from dust, dirt, corrosion.

In brief, Allis-Chalmers DZ breakers are built to assure years of dependable, trouble-free service.

Allis-Chalmers power circuit breakers are available in ratings from 2.5 to 230 kv, with interrupting capacities from 15,000 to 10,000,000 kva, to meet all industrial and power company requirements. For more information, call your nearby A-C representative, or write to Allis-Chalmers, Milwaukee 1, Wisconsin.

A-4057

Ruptor is an Allis-Chalmers trademark.

TYPE	RATED KV	MINIMUM KV AT RATED KVA	RATED AMPS	KVA INT. CAPACITY
DZ-40B*	7.2	2.3	600	100,000
			1200	100,000
			2000	100,000
DZ-60B†	13.8	4.0	600	150,000
			1200	150,000
DZ-100B†	13.8	4.0	1200	250,000
DZ-200B†	13.8	6.6	1200	500,000
			2000	500,000

*Ask for Bulletin 71B6179. †Ask for Bulletin 71B6129.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

ELECTRICAL ENGINEERING

Registered United States Patent Office

SEPTEMBER 1953

The Cover: The baking of the body color coat of paint on an automobile chassis is one of the industrial applications to which infrared is being put. See the article on pages 764–9.

TECHNICAL PAPER DIGESTS

VOL. 72 NO. 9

Statements and opinions given in articles appearing in ELECTRICAL ENGINEERING are expressions of contributors, for which the Institute assumes no responsibility. Correspondence is invited on controversial matters. Published monthly by the

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HIGHLIGHTS........

Officers and Committees. With the beginning of a new Institute year, a complete listing of AIEE officers, committee and subcommittee personnel, and representatives for 1953–54 is presented in this issue. Also included are the latest listings of Sections, Subsections, and Student Branches (*pages 825–48*).

Meeting Programs. The tentative technical programs for three coming meetings are included in this issue: the Middle Eastern District Meeting (*pages 810–13*), the Aircraft Technical Conference (*pages 813–15*), and the National Electronics Conference (*pages 816–17*).

AIEE Fellows. Biographical sketches of members recently elected to the grade of Fellow in the Institute are presented (*pages 819–20*).

Training Graduate Engineers for Professional Careers. With the increasing demand for technical people to assume management positions, it has become necessary that engineering graduates be trained in new skills that will fit them for leadership. Also, to make the best use of the engineer's talents and energies, we should utilize the services of technicians and nonengineering graduates where possible (*pages 761–3*).

Greater Safety for Textile Electric Equipment. The electric equipment associated with textile machinery long has been the principal contributing factor to the many fires occuring in textile occupancies. Lint-tight enclosures for controllers, totally enclosed or specially designed textile motors, and careful application of the electric equipment, or complete factory-engineered packaged units are suggested as methods to improve the fire record, reduce maintenance, and eliminate costly interruptions to production (*pages 771–6*).

Industrial Application of Infrared. Electric radiant ovens now are competitive with fuel-fired convection ovens in regard to operating cost in many, if not most, applications. The chief differences between various near and far infrared sources are shown to be economic. It also is indicated that radiant and convective methods rarely can be combined advantageously in one oven area (*pages 764–9*).

Automatic Control System With Provision for Scanning and Memory. This system leads to simple, easily maintained equipment, capable of setting any adjustable control to the point in its range producing a maximum or minimum of the desired effect. It is capable of an indefinitely large number of settings, depending on the input condition. If the phenomenon being adjusted is susceptible to drift with time, repeating the tuning cycle will readjust to the new position. Its low cost and applicability to a wide range of effects makes it a valuable tool in the automatic adjustment of complex equipment (*pages 782–4*).

A Level Compensator for Telephotograph Systems. This compensator eliminates interference in telephotograph transmission through broad-band carrier equipment by cancelling it from the signal delivered by the carrier facility. It consists of a pilot channel arrangement inserted in the telephotograph connecting circuits. Tests made over actual broad-band carrier facilities indicate the level compensator should greatly extend the usefulness of these carrier facilities for telephotograph transmission (*pages 787–91*).

Magnetic Amplifier Circuits and Applications. The various magnetic amplifier circuits most widely used are reviewed in their general forms. Although magnetic amplifiers are sensitive, high-gain, high-speed, versatile devices capable of delivering large quantities of power efficiently, it is seldom practical to combine all these attributes in one amplifier. Three factors should be considered in the application of magnetic amplifiers to particular problems: the signal source, the gain and time constant required, and the load into which the amplifier must work (*pages 791–5*).

Branch Circuit Overcurrent Protection for Appliance Loads. The important role of the branch circuit overcurrent protection, which is frequently the only overcurrent protection ahead of the appliance, and its relation to the satisfactory performance of electrically powered appliances are discussed. Three typical branch circuits and their protective devices are studied in some detail (*pages 778–9*).

Unique Outdoor Hydroelectric Plant. This installation represents another step forward in the growing trend toward modernization of outmoded small hydroelectric plants. Rebuilt with completely outdoor units and remotely controlled, it has operated successfully in all-season weather. Its construction and operating costs are substantially less than an indoor or semioutdoor installation (*pages 803–07*).

Nuclear Power. Being heat power it involves a heat cycle similar to conventional power plants, with a nuclear reactor replacing the ordinary boiler. Many combinations of the basic reactor types are possible, but which is best suited to economic production of power has not been ascertained as yet. There is no doubt that any high-ratio regenerative reactor will find a plentiful supply of raw materials (*pages 799–803*).

News Index

Bimonthly Publications

The bimonthly publications, *Communication and Electronics*, *Applications and Industry*, and *Power Apparatus and Systems*, contain the formally reviewed and approved numbered papers (exclusive of ACO's) presented at General and District meetings. The publications are on an annual subscription basis. In consideration of payment of dues, members (exclusive of Student members) may receive one of the three publications; additional publications are offered to members at an annual subscription price of $2.50 each. The publications also are available to Student members at the annual subscription rate of $2.50 each. Nonmembers may subscribe on an advance annual subscription basis of $5.00 each (plus 50 cents for foreign postage payable in advance in New York exchange). Single copies, when available, are $1.00 each. Discounts are allowed to libraries, publishers, and subscription agencies.

Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grades, qualifications, and fees may be obtained from Mr. H. H. Henline, Secretary, 33 West 39th Street, New York 18, N. Y.

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A compact through-supergroup filter

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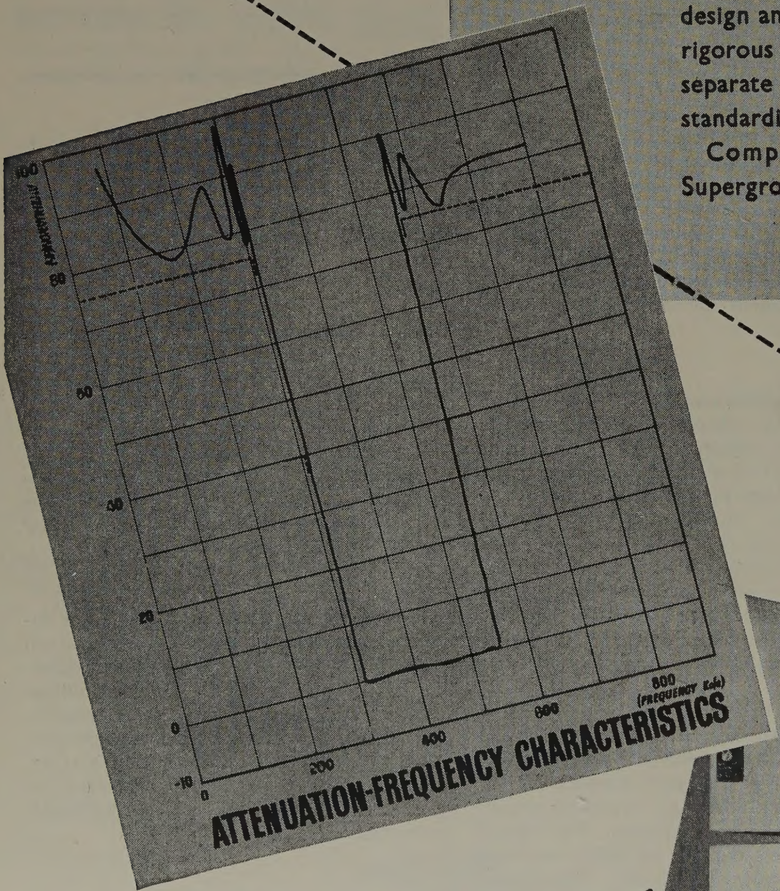
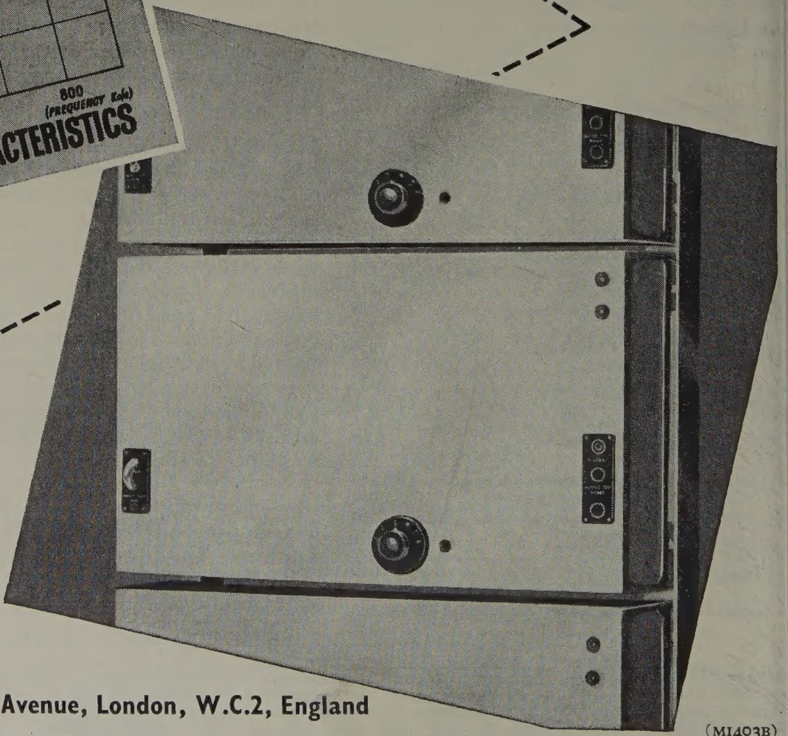
THE Mullard Through-Supergroup Filter, GTF.100, is designed for manufacture by normal quantity production methods. Conventional condensers and coils with Ferroxcube cores are used throughout. As a result, it is available at a comparatively low price. The necessary amplifiers have been incorporated in the design, so that the Filter is complete on a single 19-inch panel which is only 12¼ inches high. In both design and performance the GTF.100 fully meets the rigorous specifications necessary for filters that must separate supergroups in the frequency allocation standardised by the C.C.I.F.

Complete details of the Mullard Through-Supergroup Filter are available on request.





Mullard

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(MI403B)

Training Graduate Engineers for a Professional Career

JOHN GAMMELL
MEMBER AIEE

If we are to keep up with the steadily increasing demand for technical personnel, we will be forced to develop greater productivity per person in the future. Not only can we provide better training for those engineers who go into management and sales, but we can use the engineer's talents to best advantage by utilizing the services of technicians and liberal arts graduates where possible.

PROFESSOR P. F. Drucker of New York University has stated[1] that: "Professional employees are the fastest growing group in our work population today. . . For scientific research alone there are now about 3,000 laboratories in American industry." We are not alone, however, in the phenomenal growth of science.

According to Robert Franklin, writing in the New York *Herald Tribune*,[2] "Twenty-four of every 25 students who begin a university course in Communist China this year are being prepared for a role in China's ambitious industrialization program. Only 3 per cent of this year's university enrollment were permitted to take courses in the fine arts, law, or political science. . . By far the heaviest enrollment is in engineering colleges."

The author has made up a set of curves plotting against time the per cent of increase or decrease from 1940 until 1953 of engineering graduates, population, kilowatt generating capacity, and that statistical catch-all, the gross national product. It will be observed from these four curves, Figure 1, that we will be required to develop a great deal more productivity per person in the future than we have in the past if we are to keep up the expansion rates of recent years.

For instance, installed generating capacity in the public utility industry is doubling approximately every 10 or 12 years. Not only is it doubling in size, but it is increasing in complexity. Higher steam pressures, higher voltages, higher temperatures, higher speeds, new materials, are all items which bring headaches to the engineering department. Whether or not we need more or less than twice as many engineers for twice as big an industry, is difficult to judge. However, these trends are, on a long-time basis, very reasonable. In addition to the increase in the more basic industries, it is not hard to think of many new activities which seem to have insatiable appetites for technical people. Nuclear fission, electronics, and chemistry will involve just a few of them. Even in the homes the added technology is apparent. In 1950 United States manufacturers produced more than 20,000,000 small-size motors for homes. They hope to double the number by 1960.

In addition, there is another demand on technical people. They are being forced into management positions because they are the ones with the knowledge to solve more of the problems that beset industry than any other group. To carry the load, engineers will need much help. They will have to be better trained technically, and those who are drafted into management will need to learn new skills—skills in inspirational leadership, skills in meeting and influencing people, skills in written and spoken communications, as well as a knowledge of law, finance, accounting, and so forth—all originally alien to them. They must, to quote J. P. Magos, director of research and engineering, Crane Company, learn that "an organization chart is not the real organization," that "an executive who thinks entirely in terms of formal authority won't last long," that "if our engineer can first acquire authority of leadership and is then given authority of position, he will do a successful job."

This alarmingly small group of engineers will have to be aided also by technicians and, in some cases, by selected business, arts, and science graduates. The magazine *Time*[3] quotes a spokesman from the United States Steel Corporation as having reported that "75 per cent of the jobs for which engineers are hired could be filled by graduates with bachelor of arts degrees." The figure "80,000 engi-

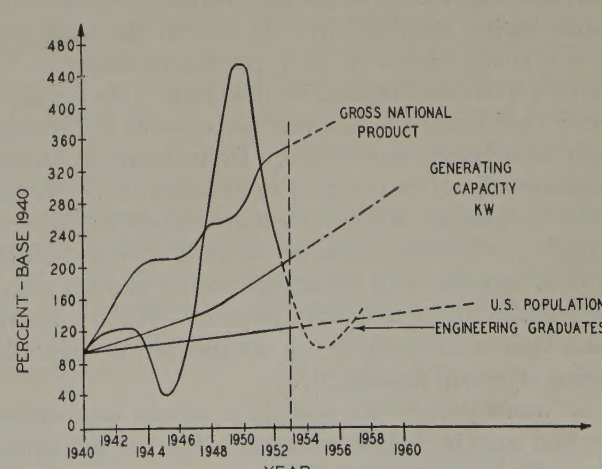

Figure 1. Approximate per cent comparison of engineering graduates to population, gross national product, and generating capacity—base year 1940

Essentially full text of a paper presented before a meeting of the West Central Texas Division of the AIEE North Texas Section at Abilene, Tex., May 13, 1953.

John Gammell is with Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

neers" needed "is never accompanied by an equally important quota of, let us say, 400,000 technicians and 1,000,000 semiskilled industrial workers." It is hard to agree with all of these figures, yet they do illustrate what many people think is a trend of the future. In this respect, market research analysts always point out that to predict what will happen during any given year is mostly guesswork, but to predict the trends over a period of years is reasonably accurate.

TRAINING ENGINEERS IN INDUSTRY

An engineer's job, the same as anyone else's, is first to be an upright citizen with a high sense of moral values. We do not want to create citizens who feel that it is all right to use their talents to build supersonic jet airplanes for military transportation while the general populace is riding in oxcarts.

Secondary to the right motivation, then, we want engineers who also have the technical ability to get us out of oxcarts into the newer and better world. In saying this, we are mindful that military jet planes may be a necessity for national preservation, but the real end is better transportation.

When engineers come out of college, they are, in the words of Dean R. E. Doherty, formerly of Carnegie Institute, "mentally clumsy, relatively narrow in interest and perspective, and awkward in writing and speech" and "practically incapable of analyzing problems or situations in terms of general principles." Because of this, they tend to "remain in the comparative isolation of technology." Industry, at this point, must take the raw recruit and adapt him to practical usefulness.

In the author's company is an initial training course which lasts up to 2 years. During this time, we may rotate the students into 20 or 30 different departments. We give them the equivalent of 10 to 20 weeks of lecture and discussion. We also send them to three or four different plants, and we encourage them to take night-school courses, a large share of the expense of which the company pays.

During this training period, the student interviews prominent men of the company. He talks over with them his hopes for the future. The student chooses where he wants to work during training. We do this on the basis that, here is a young man with 16 years of schooling who has survived a great deal of selective discipline. He should be a pretty level headed person and he probably understands himself a lot better than we do. He is, however, lacking in the knowledge of the company and its activities. We give him this knowledge; we also give him aptitude, intelligence, personality, and preference tests. We talk over these things with him, together with his college record and his record in the training locations in our company. When a student has this kind of information, we are inclined to regard his appraisal of himself most highly.

If he wants permanent work in a certain department, we let him train in that department. If he can sell himself to his section head as a regular employee and the department needs a man, then we think it is a good placement. If he cannot sell himself in that location, he tries another. If he finds a location early in his course and he does not have sufficient background to handle it properly, he continues training in other departments until he and his future boss are satisfied. We have been doing this for a long time and it works well.

It is interesting to note that we have 61 recognized "training locations" and a number of others as yet indefinite. Taking the minimum recommended time in each of the 61 locations, we arrive at a total of 123 months. This can be regarded as the potential from which a new trainee may choose to work out the customary 24-month course. The 123 months' potential is 5.13 times the customary 24-month course. It represents a period of 10 years and 3 months.

SALES TRAINING

Many of the professional people go into sales. Our products are highly technical and there is a large variety of them, so that they provide a stimulating career for the sales engineer. Since we have so many products, we are inclined to want the sales engineer to stay on training for the full 2 years, and most are more than glad to do it.

An engineer, however, is not naturally a salesman either by inclination or training. The same could be said of those engineers who find themselves in administrative tasks. Dr. R. W. Wallen, associate professor of psychology, Cleveland College, says of engineers as opposed to salesmen:[4]

> They are interested in logic as opposed to feelings. Many of them believe that you can persuade people by means of logic better than any other way and, of course, this is not true.

We are, to some extent, then, in the process of changing a personality. Dr. Wallen says further:

> If we tend to make engineers switch about completely, we run the risk of depriving ourselves of certain social contributions. And we may produce a bunch of frustrated people who feel guilty because they can't change and think they should.

This factor seems to have been avoided here because we let the engineer who has an interest in sales select such a career himself after he has had some opportunity to see approximately what it is like in our particular company.

We make a great effort to establish in the minds of these people that good salesmanship begins with product knowledge but that it does not end there. We stress to the sales engineering prospects that the principal means of communication with other people is the spoken word. Engineers, of course have other means of communication, such as mathematical symbols, diagrams, and blueprints. However, even the most abstruse symbols require words at some point to establish their meanings. Every salesman should be able to talk easily, interestingly, and effectively about the product he has to sell. If he cannot do this, he does not easily fulfill his mission, which is to see that information concerning needs is sent from the field to the factory, and that information concerning equipment is sent from the factory to the man who can use the equipment to advantage.

In reading about most great inventions, we are struck

with the fact that many people thought of the invention at about the same time, but the man whom we read about today as the inventor was the one who had a sales engineering approach. He sold his idea and saw that it was made useful to many people.

We show our future salesmen many films on human relations. We are aware that progress in this area comes slowly, since it has to be superimposed on a personality pattern that is already well established. But, progress can be made. Fortunately, most of our sales engineers will call on customers who are highly skilled in our products. Occasionally, however, they do have to talk to people who are less favored in technical ability.

To quote Dr. Wallen again:

> Engineers need to learn a lesson in humility. They need to grant validity to another person's point of view. Simply because they are oriented toward numbers does not mean that other people who are not number-oriented have nothing to offer our world.

HUMAN RELATIONS AND THE PROFESSION

There is yet another field of training which can be introduced by the idea of human relations in engineering. That is, what we do about inculcating a spirit of professionalism in our students. While we have no fixed policy on the matter, we do encourage our students to become registered engineers and to take whatever examinations are necessary toward this end. We encourage them to belong to professional societies and to attend their meetings. It is our hope that while they are doing so, they not only will maintain an "up-to-dateness" in their technical knowledge, but they will absorb some of the outlook of the true professional man.

The following is a definition of a profession as worked out by one of the Wisconsin Society of Professional Engineers committees:

> A profession is a calling dealing with spiritual, physical, or social laws, principles, and aspirations, and requiring expert knowledge, inherent skill, and strong moral purpose in the application of the same to the conduct of life and the affairs of men.
>
> A truly professional man has unique contributions and ideas to offer to his employer. If he is truly professional he is happiest when making individual contributions rather than when submerged in collective operations. Nevertheless, he must work well with other people. He deals with his superiors on the basis of these unique contributions or the possibilities of them. His whole attitude is and should be highly individualistic. He may not conform to rules or arbitrary standards readily.

In the words of Professor Drucker:

> Professional employees do not fit into the administrative process—and the administrative process does not fit them. In particular, the very concept of "supervision" goes against the grain of the professional employees. . . Thus, the superior should be a co-ordinator or teacher rather than a supervisor.
>
> If a professional man finds himself in a position such that no professionally unique contributions are possible or apt to be possible, then he is in a job suitable for a technician. He has given up the profession either by choice, necessity, or because he is unwilling to assimilate the professional point of view. No man with something special to offer will submit to organized group treatment or, for that matter, to group treatment by an employer.

Professor Drucker also wrote:

> Indeed, the professional employee who becomes disgusted when he is being used as a technician is better than the one who accepts complete subordination of his craft to business rationale. For the latter becomes a cynical hack and will soon cease to make any contribution to the business—even as a technician.

The work of technicians should not be minimized, but one must consider that there are jobs requiring different abilities. Henry Ford, James Watt, and, possibly, the Wright brothers, would seem to be technicians, rather than engineers, but they were eminently successful.

It is not easy to get a true professional employee or his management to accept these truths. Management, in particular, has its difficulties with professional people.

"These people want perfection; they don't care a rap how long it takes, how much it costs, or whether anyone else wants perfection anyway. They always want another 4 weeks to improve the job just a little more," says Professor Drucker. Or again, "He does not think of himself as working for the company but rather regards the business as his laboratory, if not his guinea pig."

This monster, collective thinking among professional engineers, has been characterized by Dean W. R. Woolrich as "legalized mediocrity." It seems we have here strong opposing forces which well may destroy much of each other if they insist on proceeding toward battle.

In the author's company, we try earnestly for the spirit of engineering in our training and the opportunity of progress in our placements. We do not want to hold a man with us if we have nothing for him, and we do not want him to leave if we have. We are aware, however, that if you can keep a good man patiently at a task, he sometimes makes a professional job out of an apparently lowly operation. When this happens, we have true progress.

We then either must have a position for an engineer or inspire him to make his job into one suitable for an engineer, or we ought to hire technicians or liberal arts graduates. This we attempt to have recognized in all of the vast areas of our large corporation.

As with most operations involving people, we eventually end up with concepts of action higher than can be expressed by facts and figures. No amount of planning and system is, in itself, an answer to true professional training problems. The apostle, Paul, states, "The letter killeth but the spirit giveth life."

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1. **P. F. Drucker.** *Journal*, American Society of Naval Engineers (Washington D. C.), November 1952.

2. **Robert Franklin.** *Herald Tribune* (New York, N. Y.), November 30, 1952.

3. *Time* (New York, N. Y.), April 21, 1952.

4. **R. W. Wallen.** *Cleveland Engineering*, Cleveland Engineering Society (Cleveland, Ohio), March 5, 1953.

Industrial Application of Infrared

I. J. BARBER
MEMBER AIEE

The current thinking concerning the peculiar advantages of this method as compared to other methods of heating, and the variations of equipment in use within the infrared process itself are presented.

THE INDUSTRIAL marketing and application of the type of electric radiant equipment generally referred to as "infrared" is now halfway through its second decade. Infrared has lived successfully through its earlier, more glamorous years as a mysterious catalyst with unlimited potential; it has survived being oversimplified by the swing back to realism. It has been subjected to a great deal of abuse by irresponsible commercialism and unintentional misapplication and has had many successes and failures. The fact that it is today a recognized and reputable heating means in some of the largest installations and in some of the largest industries is testimony to the basic worth of the process. See title picture and cover.

As such a recognized process, it competes largely with convective, and to some extent conductive, methods of heat transfer in most of the low-temperature (below 600 degrees Fahrenheit) product-heatin markets. The last 15 year of trial and error have verifie some early conclusions an refuted others.

Briefly, in contrast to con vection heating, infrared pro vides economical means for quickly raising temperatur levels in products having a wide variety of shapes, sizes and weights. It has proved to be more easily adaptable t products having thin and thick sections because of the in tensity levels that can be created and maintained in an desired region; the ability to "zone" ovens radially as wel as longitudinally, and to revise such "zoning" quickly an economically by simple lamp changes or switching has mad it far more flexible than competitive means. The abilit to process economically with "clean air" and the electri

Revised text of a conference paper presented at the AIEE Winter General Meetin New York, N. Y., January 19–23, 1953, and recommended for publication by the AIE Committee on Production and Application of Light.

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interlocks that permit immediate collapse of radiation with conveyor stoppage have provided factors of safety in ovens which were previously unattainable. No other heating source has enjoyed the safety record that has been attained by properly applied infrared. Nearly all of the few recorded fire losses in infrared ovens have been traced to installations which disregarded the simple and obvious regulations which apply; mostly, they were crude or home-made structures with little or no ventilation means. Properly engineered infrared installations with modern equipment have proved that electricity can be competitive, on an over-all operating cost basis, with any other fuel. This represents a considerable change in thinking from earlier years, when it was generally believed, if not conceded, that, being an electrical process, it was necessarily many times more expensive than gas or steam. Similarly, many old beliefs, such as "infrared is only all right for flat simple products such as ash trays," are seldom heard. Whereas, at one time, it was thought that materials required reformulation for infrared processing, it now is generally conceded that any material responsive to heat processing (under 600 degrees Fahrenheit) can be done with infrared. Considerable data support the present feeling that critical materials can be processed on a short cycle more safely and to a better end result by means of short-wave radiation. Evidence is at hand indicating that radiant penetration is important in the processing of many materials, and while no attempt is being made to claim any magical properties, it still is not safe to stand on the "heat is heat" basis without clearly understanding that the ultimate location of the heat must play a part in any analysis.

From the users' standpoint, possibly the most confusing thing about infrared is its name. Had it been commercially launched as radiated heat, there probably would have not been the degree of misunderstanding that has surrounded it more or less from the start. However, the novelty and mystery were perhaps necessary in the beginning to interest a prospective user and to bolster his credulity to the point where he was willing to undertake the use of the new medium. But from the standpoint of simplification, now that it is conceded generally that benefits from its use do exist, it might have been said and may be said now that heat radiation referred to as infrared and sometimes complicated by division into "near" and "far" infrared exists over a very broad band. Just to refresh the perspective, consider that the heat radiation band exists all the way from the visible at approximately 0.8 micron to 400 microns, see Figure 1. Over this entire range, its gradual change from short to lengthy waves is in a stepless curve. Somewhere near the short end of this curve, an attempt at division has been made, the exact location of which never has been determined. There is not much in the characteristics of the radiation itself to suggest a line of demarcation. It has been placed by different authorities at some point between 3 and 5 microns, probably because early researchers found it necessary to make a change in measuring equipment at somewhere near this point. Due to the fact that glass lenses and prisms were employed at the shorter wavelengths and that their transmission factors decreased fairly abruptly within the range from 3 to 5 microns, it was necessary to go to quartz and other rock crystalline material in order to secure results. Also, the absorptivity of water or water vapor commenced to assume serious proportions within the same range. Most other translucent materials such as pliofilm, ethyl cellulose, cellulose acetate, cellophane, lucite, and so forth, do not display absorption bands of any magnitude under 7 or 8 microns, see Figure 2. One other characteristic of heat radiation which might have some significance is the fact that visibility of heated objects disappears at somewhere around 850 degrees Fahrenheit which corresponds to a color temperature of 4 microns. If there is any real need for a division between areas of the infrared spectrum, there might be more justification for selecting 4 microns than any other point, largely on the basis of the absorption of water vapor in the air, of glass, and of the previously mentioned departure from visibility.

Infrared radiation of some type or quality exists with any object at a temperature higher than its surroundings. Conventional convection ovens provide a considerable quantity of heat transfer by radiation from heated walls. The higher the temperature of the oven, the greater percentage of its energy is transmitted in this manner. It may be worth repeating that there is no commercial oven or furnace which is wholly radiant or wholly conductive although fairly wide differences in percentages of each are involved.

The earliest commercial lamp installation involved the carbon filament lamp at approximately 2,000 degrees Kelvin and gave impetus to a commercial industry largely for two reasons: First, the high temperature of the filament permitted it to be of small mass which not only made control by the use of reflectors practical, but also introduced the relatively instantaneous response to impressed voltage changes. Second, because of the characteristics of the radiation, the source itself did practically no air heating, since almost 75 per cent of its energy was radiated in the region below 3 microns (83 per cent at 2,500 degrees Kelvin). This made it practical to enclose it

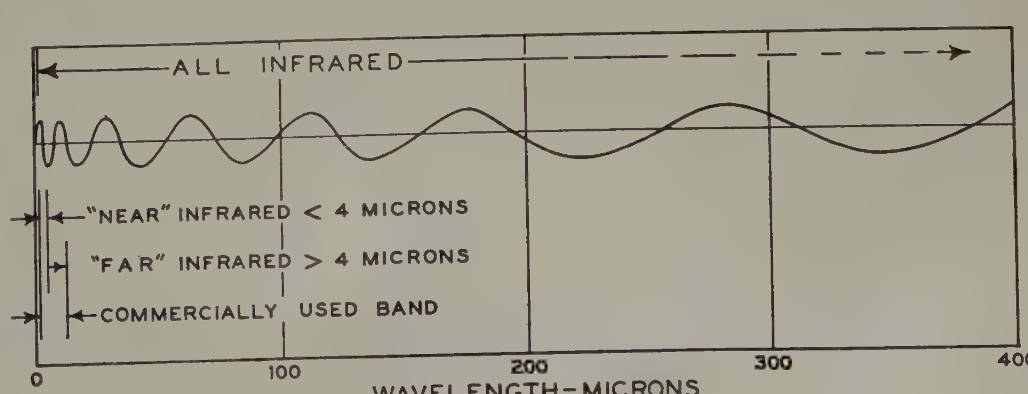


Figure 1 (right). Presently used frequencies

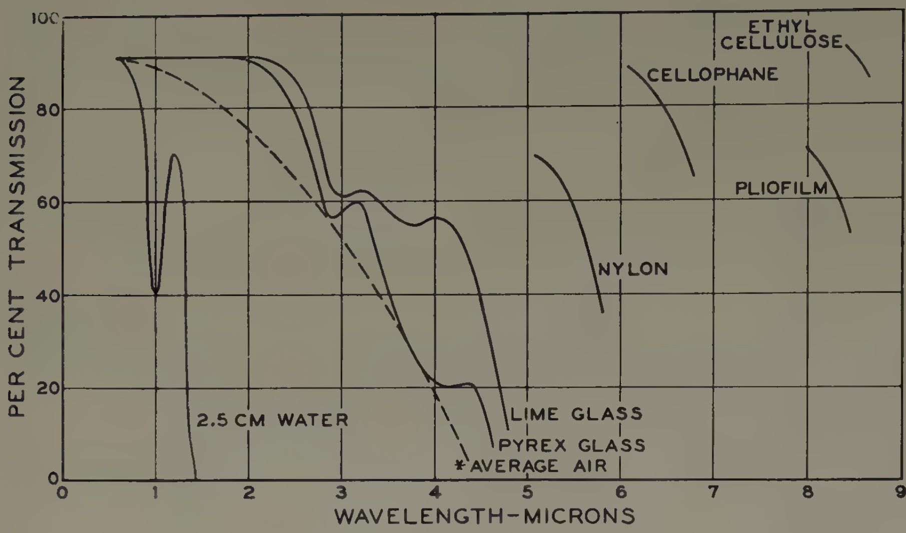


Figure 2. Relative infrared transmissions

* *Variable with water vapor and carbon dioxide content*

in a glass enclosure which protected the source from serious convection loss. For manufacturing and procurement reasons as well as a longer useful life, the principal commercial source was shifted to the tungsten filament at 2,500 degrees Kelvin which is still mainly being employed today.

The principal drawback to the use of lamps developed from the relative fragility of a glass bulb and its limited resistance to mechanical and thermal shock. These weaknesses, which are not too serious when given due professional consideration, were greatly exaggerated by the misleading apparent simplicity of application. Many people built their own so-called ovens, utilizing materials at hand and guided by little or no experience. Under these circumstances, the failures of lamps were sometimes quite pronounced, both from the standpoint of accomplishing the end result and also from the standpoint of showing any appreciable life. Misadventures of this sort turned the thoughts of many users to the more rugged, nichrome elements in ribbons, coils, or encased in metal tubes. Preliminary investigations indicated that these sources would do most of the jobs that the lamp would do and were definitely more rugged and resistant to thermal strain. While they introduced these advantages into the oven, they also introduced some disadvantages. First, due to their much greater mass, they were no longer immediately responsive to voltage control. Second, because of their longer wavelength characteristics, they were partly air heaters with some resultant loss in operating economy and it became desirable to take that factor into consideration in oven design. Third, because of being air heaters, they required time to bring an oven to stability. Similarly, they were not quick to collapse or decrease rapidly in temperature in the event of shutdown and consequently, presented some danger of overbake in the event of accidental stoppage. Fourth, they were not readily available in a range of interchangeable wattages for general equipment and consequently did not lend themselves to the degree of zoning possible with lamp ovens. This objection was overcome, at least in part, by the use of interval timers. Because of the inherent lag in temperature change in the element, intermittent or percentage operation had the practical effect of varying the apparent rating of the element. While this method of control also modifies the effective color temperature of the source and slightly shifts the ratio of radiated to convective output, it is not generally a major detriment. Fifth, because of a currently higher first cost and a higher replacement cost, there developed some economic resistance to widespread use.

One or two other properties might be examined at this point. The first relates to the relative absorptivity of different materials when irradiated at different frequencies. The absorption points of some materials are shown in Figure 2. It will be seen that the majority of them fall beyond the 4-micron point. Therefore, equipment designed specifically for first pass absorption on these materials probably should be operated at color temperatures in excess of this point, which makes them probably essentially black sources, that is, sources with little or no visible radiation operated at color temperatures in the vicinity of 600 to 700 degrees Kelvin or lower. A modification of this apparently clear-cut solution is that where the relatively transparent material is backed with a reflector permitting several passes of radiation back and forth through the material, the equivalent net absorptivity may be obtained with sources of much higher color temperatures—even including 2,500 degrees Kelvin. Similarly, where this is not feasible,

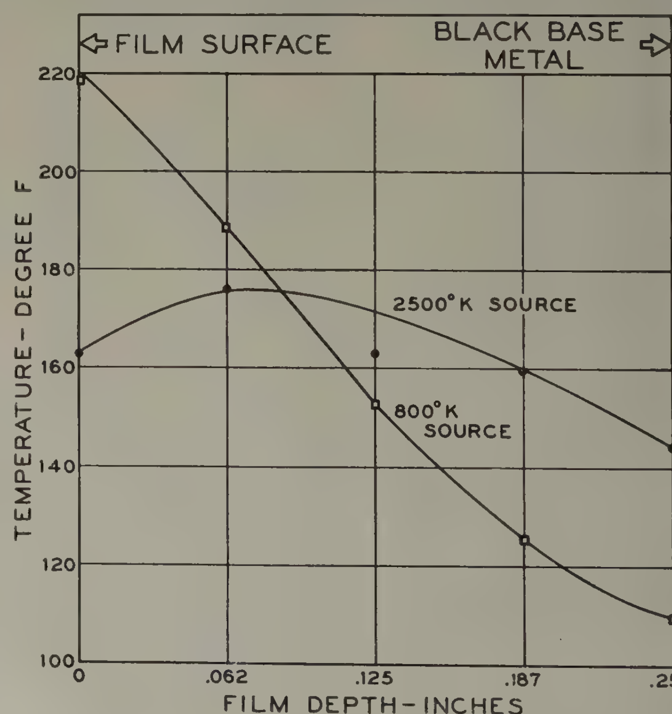


Figure 3. Temperature gradients of radiated paint films

it is often possible to run multiple passes of the same material in the path of one radiating source, which produces relatively the same effect of high absorptivity in the short-wave range.

Since a great proportion of the commercial installations of infrared are for the purpose of processing paint films on metal surfaces, it is interesting to study the relative effects of high- and low-temperature sources on these films. To date the writer knows of no practical method to read accurately the temperature gradient across a 3- or 4-mil-thick film of paint. It has been possible to determine the percentage of transmission at various depths and to determine the relative absorptivity of different types and colors of pigments. Since clear varnish films transmit most of the radiation in thin films but absorb essentially all of it if a thick enough film is used, it is concluded that it might be possible to approximate thin film gradients by actual temperature measurements on a much thicker film. This conclusion introduces the error, however, of assuming that the thermal conductivity of the film near the surface would be similarly reduced which produces a quantitative error of some degree. It should not, however, affect the basic conclusion shown in Figure 3. This is of considerable significance because it illustrates that in this instance without exceeding a film temperature at any point in excess of 176 degrees Fahrenheit, it is possible to process a film at an average temperature of 160 degrees Fahrenheit where a high-temperature source is employed, while with a source of low color temperature, a maximum film temperature at the surface of 220 degrees Fahrenheit would be required. At equal oven ambients, this would appear to indicate a surface convection loss 50 per cent greater in the case of the low-color-temperature source. It would indicate also that on a critical material, it would not be possible to process the film safely at as high a rate with a low-temperature source as with a high-temperature source. Other data exist supporting the same conclusion.

Other still lower temperature sources of various kinds are on the market, although none is as yet as widely used as the lamp. Among these is the low-temperature (500 to 600 degrees Fahrenheit) panel of coated glass or of metal or of fiber glass plus nichrome wire. This type of unit provides a surface which is largely all heated in order to provide total intensity within the range of the other commercial sources. Inputs in the neighborhood of 2.5 kilowatts per square foot can be procured in some cases. Like all of the sources except the glass-enclosed types, they may be operated as low in color temperature as desired. Like the metal element, they have considerable mass and consequently are slow to respond to controls. This, however, makes control by interval timer useful.

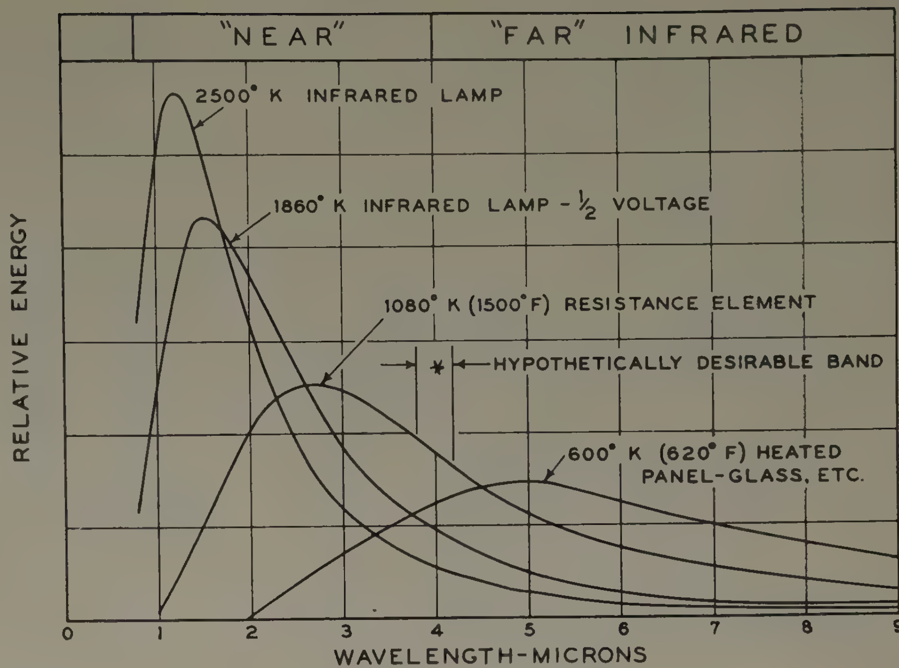


Figure 4. Radiation ranges of commercially practical sources

* *Band not significant—for illustration only*

One of the earliest thoughts in connection with these wavelengths and one which was encountered frequently during the earlier days was the idea that a fundamental spectral frequency based on resonance or its heating equivalent existed for specific materials and that extreme efficiency could be developed by providing radiation of exactly this frequency. While there might be some truth in the basic speculation, it soon became apparent that with any known method of producing heat radiation, the possibility of restricting it to a narrow band existed only through the use of filters. Since this was a purely subtractive process, about the only practical approach that ever was developed was the use of ruby glass to filter out the small proportion of visible light from the short end.

A study of the distribution curves reveals that for sources from 2,500 to 600 degrees Kelvin, there is a great degree of overlap between all temperatures represented. Thus, if 4 microns were selected as the desirable frequency for a given operation, it would be found that all four sources here considered would yield approximately 5 per cent of their energy between 3.8 and 4.2 microns, and it would be necessary to waste 95 per cent of the radiated energy through some filter medium in order to achieve this type of distribution. See Figure 4.

The matter of color differentiation has been a source of considerable study and a small amount of data concerning it is available. Like many other of these qualities, it presents a steadily changing curve almost linear in form. The curve shown is supported by some laboratory data and may point the way toward a usable tool to pick out the particular required span of ratios. Thus, it will be seen that no source is completely color blind, but becomes less color sensitive with increasing wavelengths. This finding is modified by another important physical law. It is fundamental that any body totally surrounded by a 100-per-cent

reflective enclosure becomes a perfectly black body. In effect, this means that there is no difference in the effective absorptivity of a black object and a white object irradiated by waves of any length where the target and source are surrounded by a perfectly reflective sphere such as one gold plated on the inside. Thus, any difference between peak wavelengths disappears under these circumstances. It is, of course, not possible to duplicate this condition in practice but a definite approach in that direction can be made by having as large a percentage as possible of the oven interior reflective. In a long cylindrical tunnel, it is possible to approximate as high as 80-per-cent reflective walls. And under these circumstances, the span between color extremes becomes quite narrow. It readily may be seen by reference to Figure 5 that an oven with a 2,500-degree-

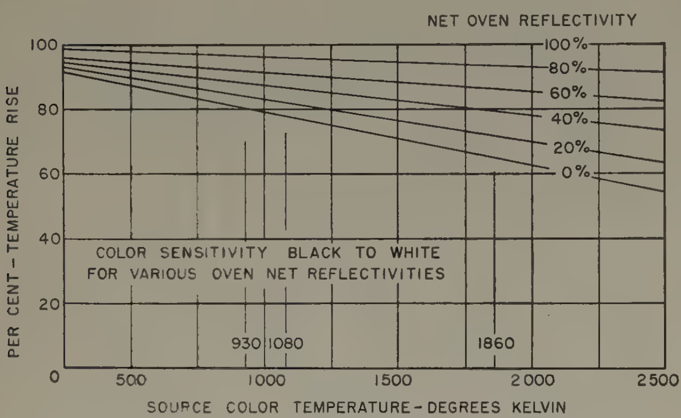


Figure 5. Interrelation of oven reflectivity and source color temperature on color absorptivity effect

Kelvin source designed to provide a 70-per-cent reflective interior may have better color performance than an oven as high as 20-per-cent reflective, equipped with 930-degree-Kelvin elements. Since many of the ovens utilizing the lower temperature sources are built with little regard to reflective walls, it is apparent that designating such equipment as color blind is not factual.

Nevertheless, while there are legitimate bases for utilization of these various sources, revolving around specific conditions, they introduce certain problems of oven construction which are worthy of thought at this time. Of the sources currently available, practically all may be operated over a fairly wide range of temperatures and corresponding frequencies. Thus an incandescent lamp in a glass envelope may be operated safely at a filament temperature from 3,000 down to about 1,500 degrees Kelvin where the glass absorption commences to become excessive. The conventional 2,500-degree-Kelvin lamps may be operated within the approximate range of 1,860 to 2,700 degrees Kelvin by varying the voltage impressed across them. This voltage may be modified by some form of voltage regulation or by series or series parallel connections. They may be satisfactorily controlled, in most cases, with interval timers. The fact that their immediate response to voltage change does not permit "smoothing out" or averaging the source intensities is often compensated at least in part by the product's lag in response. Such control, generally operated between two voltage levels, rather than "on and off," does not appreciably shorten lamp life or have other adverse effect. Below 1,100 degrees Kelvin and down to practically room temperature, open or sheathed resistors are available. Where essentially "far" infrared radiation is desired, heated panels which can be glass or metallic or fiber glass pads are available. They might be classified as the only predominantly "far" infrared sources of adequate intensities commercially available today. Resistance units may be operated at low enough temperature to meet this classification but require so many elements within a given area to provide sufficient intensity that they become commercially impractical. Other elements such as glass tubes containing resistance elements, fused quartz envelopes containing resistance elements, ceramic-coated resistance elements, and so forth are commercially available and exhibit some peculiarities of construction. They all, however, fall somewhere in the range shown on Figure 5 and provide performances corresponding to their positions in the spectrum. The two extremes currently in use are represented by the 2,500-degree-Kelvin lamp which has $91^1/_2$ per cent of its radiation at wavelengths shorter than 4 microns and hence might be classified as being $91^1/_2$ per cent a "near" infrared source and heating panels which at 600 degrees Kelvin have only 14 per cent of their energy below 4 microns and consequently are 86-per-cent-"far" infrared sources. Some common commercial sources are given in the following tabulation:

	Degrees Kelvin	Less Than 4 Microns	More Than 4 Microns
Filament lamps	2,500	91.5	8.5
Same at half voltage	1,860	83	17
1,500-degree-Fahrenheit elements	1,080	54	46
1,200-degree-Fahrenheit elements	930	43	58
620-degree-Fahrenheit panels	600	14	86

Since the "near" infrared sources lose little of their radiation by absorption in the air, it follows that they are primarily directly radiant units. Ovens designed for their use must, therefore, be governed by the cardinal rules of control of radiation, which are

1. The highest percentage of oven wall reflectivity possible.

2. Reflective distribution control for initial uniformity of impact.

3. Since the air in such ovens is heated largely by the product, efficiency demands a minimum of turbulance and air movement, good housekeeping in operation.

Ovens constructed for utilization of this source therefore will pay maximum attention to maintenance of proper reflectivity with no importance attached to the exterior or between-the-wall insulations in the conventional sense.

On the other hand, ovens constructed for use with the "far" infrared sources which are predominantly air heaters, must take this fact into consideration to obtain comparable efficiencies. Thus the maintenance of a high ambient within the oven indicates a desirability of wall insulation and other forms of heat retention. Since a considerable

portion of their function is still radiant, however, the factors of good housekeeping still must be present and to a lesser degree, radiation control is desirable.

Comparing the qualities of the two general groups of infrared generators, the tabulation perhaps would resemble the following.

Filament lamp (high-temperature) sources:

1. Low mass of filament permits instantaneous response to control.
2. Small physical size of filament permits efficient directional reflection.
3. Lowest first cost and replacement cost.
4. Little air heating permits quick starts and safe shutdowns.
5. 5,000 to 10,000 hours life.
6. Absence of air heating losses usually permits higher operating efficiencies.
7. More uniform temperature gradient through paint films provides a better quality product.
8. Shortest safe cycles.

Open or lower temperature source:

1. Greater mechanical strength.
2. Less color sensitivity.
3. Greater resistance to thermal shock.
4. 5,000 to 10,000 hours life.
5. High percentage of surface heat on water dry off.
6. Averages out well when using interval timer control.
7. Absence of occasionally objectionable glare.
8. Minimum space requirements.

The foregoing examination of characteristics indicates that the commercial applications for which each source might be most suitable would be as follows.

Filament lamp (high-temperature) ovens:

1. Paint baking—best film gradients.
2. Water evaporation—bulk quantities.
3. Irregular products—easier radial and longitudinal zoning.
4. Inflammable products—cloth, paper, and so forth—safety during shutdowns.
5. Intermittent lines—safety during shutdowns.
6. Shortest safe cycles.

Lower temperature source ovens:

1. Surface water dry off.
2. Light-sensitive materials (photographic and blueprint).
3. Better efficiency on skin drying.
4. Food products—where glass breakage is important.
5. Glass and other transparent materials heating.
6. Rugged operating conditions.

In summation, it may be said that infrared has established a definite and lasting place in industrial heating. It possesses properties which are quite desirable in some instances, and it can compete successfully in many processes. The variety of generating sources is increasing and some valuable properties can be attributed to many of the new units. However, the lamp today remains the cheapest and most generally adaptable device for producing radiant energy and probably will maintain its position for some time to come.

Crystals With Remarkable Memory Properties Developed

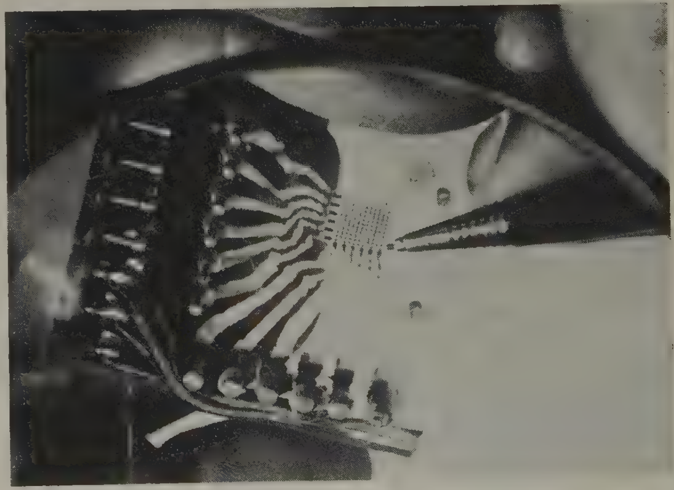
Flat crystals, a few thousands of an inch thick with the unique ability to remember vast amounts of information, have been developed by Bell Telephone Laboratories. One such ferroelectric crystal half an inch square can store approximately 250 bits of memory for an indefinite period. Light amber-colored, these crystals are artificially grown from the chemical barium titanate.

A few square inches of the crystals have a potential for information storage equal to many cubic feet of currently used apparatus. Hence the crystals may have profound significance in decreasing the space occupied by telephone switching systems.

The memory crystals store their information in the binary code, consisting of only two symbols designated by either a "yes" or a "no." Words, sentences, or a series of numbers can be coded by using a large number of these symbols.

Coded information is fed into the crystals by the simple application of a plus or minus voltage, depending on whether a yes or no is desired. The information can be retained indefinitely in the crystal.

When the crystal is read out, it simulates the human process of "bring to mind."



Tiny crystals a few thousandths of an inch thick and a quarter of an inch square with remarkable memory properties have been developed. Note the fine electrodes which carry the information, in the form of electric charges, to the crystal. Circuits then interpret the stored charges in a millionth of a second, using but microscopic amounts of electricity

Arc Interruption Phenomena in a Magnetic Field

J. P. DALLAS
MEMBER AIEE

ARC IMMOBILITY and arc reversal phenomena limit the use, affect the design, and dictate the test procedure required for aircraft circuit interrupting equipment using magnetic arc suppression. Laws of physics which earth-bound electrical designers use unquestioningly are found to require re-examination when applied to magnetic arc interruption equipment for use at altitude. It had been assumed for more than half a century that an electric arc, like any other conductor free to move in a magnetic field, would move in a direction determined by Ampere's Law. This assumption is valid, for all practical purposes, for circuit breaking equipment operating at sea level. However, as the altitude is increased, an electric arc in a magnetic field may falter, stop, and finally reverse its direction of motion.

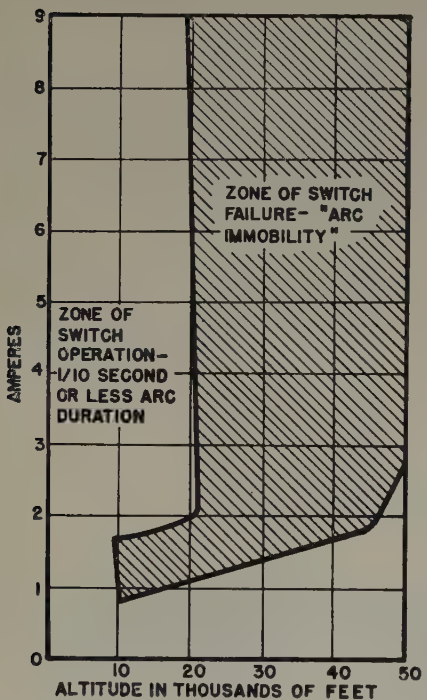


Figure 1. 0.035-inch contact gap; 300-gauss permanent magnetic field

Arc Immobility. Referring to Figure 1, an aircraft limit switch with an Alnico magnet located to produce a transverse field of 400 gausses in the contact gap was operated in an altitude chamber with provisions for photographically recording the results. In Figure 1 a discontinuity appears between 10,000 and 20,000 feet. The switch did not interrupt values around 1 ampere while interrupting values from 2 to 9 amperes. This disconcerting discontinuity in interrupting capacity was caused by arc immobility.

Comment and Conclusions on Arc Immobility. There is agreement that arc immobility and reversal in a transverse magnetic field are the result of two opposing forces, one acting on the arc plasma or column to drive the arc in a normal direction in accordance with Ampere's Law, and the other force acting in the opposite direction on the cathode spot. Reference material does not provide any agreement on the causes of these phenomena. Therefore, the following explanation of the discontinuity in the interrupting capacity of the switch in Figure 1 is proposed.

If the force acting on the arc column is assumed to be $F=I\times B\times L$ where I equals the arc current, B equals the total field flux acting on the arc column, and L equals arc length. It is apparent that decreasing I, the arc current, or L, the arc length, would reduce this force tending to drive the arc in a normal direction. If such reduction of the normal arc column driving force results in immobilizing the arc at some current value above the interrupting capacity of the simple switch gap, it is obvious that a discontinuity in the maximum current interrupting capacity of the switch characteristic would appear. For example, referring to Figure 1, we may regard the lower limit of the discontinuity, the line from 10,000 feet and 3/4 of an ampere to 2 $^3/_4$ amperes at 50,000 feet, as representing the arc interrupting capacity of the switch gap without magnetic arc suppression. The upper limit of the discontinuity represented by a line from 10,000 feet and 1 $^3/_4$ amperes to 21,000 feet is roughly the boundary at which magnetic arc suppression starts to be effective because the increased I has increased the forces acting on the arc column sufficiently to produce arc motion in a normal direction.

Small gap arc immobility and transient arc immobility, considered at some length by Sake Yamamura, are explained easily once the concept of the critical nature of arc length is understood. Both of these phenomena are the result of low normal-direction driving forces on the arc column due to its short length. It is obvious if the driving force on the arc column is $F=I\times B\times L$ that L, the arc length, must reach some substantial value before the driving force on the arc column is sufficient to produce motion. The time interval, then, between the start of switch opening and the time the arc length is sufficient to produce effective arc column driving force is the "Transient Immobility Time" noted by Sake Yamamura in the *Journal of Applied Physics*, March 1950.

It is suggested that improved performance of aircraft switches and relays incorporating magnetic arc suppression may be achieved by designs concentrating the magnetic field on the arc column and/or shielding the cathode surface from the magnetic field.

Digest of paper 52-333, "Arc Interruption Phenomena in a Magnetic Field at Altitude," recommended by the AIEE Committee on Air Transportation and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Middle Eastern District Meeting, Toledo, Ohio, October 28–30, 1952. Published in AIEE *Transactions*, volume 71, part II, pages 419–22.

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Engineering Safety Into Electric Equipment

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MEMBER AIEE

Fire hazards in textile factories are scrutinized and suggestions are presented to improve the electric equipment and therefore achieve safer and more trouble-free installations.

MANY improvements have been made over the years in the machinery used in the textile industry in order to improve the quality of the product, increase production, and reduce the cost. The electric equipment associated with the textile machinery also has been greatly improved in many ways but insufficient attention has been given to eliminating the fire hazard which is inherent with most electric equipment.

FIRE LOSS EXPERIENCE

WHEN ELECTRICITY first was used in the textile industry, the motors were merely a means of driving the machines and they and their controls were relatively simple too as compared with equipment in use today. Such requirements as variable speed, easy starting, quick stopping, or co-ordinating the speed between sections had to be accomplished through mechanical means. Today, however, electric motors and controls are available that will perform readily and satisfactorily all of these functions. They are however more complicated in many instances than the early equipment and much greater in number because of the general use today of individual drives. This increase in the complexity and quantity of electric equipment in occupancies where highly combustible materials are handled or processed naturally has caused a considerable increase in fires due to electrical causes.

It is obvious that every precaution should be taken in such areas to guard against all sources of ignition, yet fire after fire continues to occur, originating in the same type of electric equipment and for the same reason. In many instances those in charge continue to accept the fires as a matter of course, a necessary evil, and do little or nothing to prevent a repetition. After each fire the damage is cleaned up and repairs made to the electric equipment and the same device or another of exactly the same type is installed in the same old way, with little if any constructive thought being given to changing the design or location or applying some other reasonable loss-prevention measure. The solution however does not always lie wholly in the hands of the owners because, in many cases, they often are doing the best they can with the equipment that is available without going to unreasonable expense.

The following statistics on fires in cotton mills for the 10-year period 1940–1949 show that there is a definite need for improvement in the electric equipment used in textile plants and the method of installation. These statistics cover only those fires for which claims were made and which occurred in plants insured by the Associated Factory Mutual Fire Insurance Companies. Many other fires occur which are of a minor nature and the losses are too small to bother with making a claim. Some of the larger mills have a policy of making no claims for compensation unless the loss exceeds $50 or $100 or some similar amount which has been decided upon. If these fires were known and included in the statistics, the record without doubt would be much worse than it is. Also, if similar statistics were available on fires in those other cotton mills which are insured by other companies the results would be even more impressive. Furthermore, it is important to remember that the Factory Mutuals insure only the preferred class of risks and the loss record in those plants that do not qualify as preferred risks is probably much worse.

All fires in cotton mills for which claims were made to the Associated Factory Mutual Fire Insurance Companies between 1940–1949:

Occupancy	No. of Fires	Property Damage	Use and Occupancy Loss
Opening and picking	3,455	$ 990,000	$102,000
Carding through weaving	3,431	1,055,000	160,000
Finishing (includes napping and drying)	636	703,000	170,000
Storage	394	1,430,000	2,000
Total	7,916	$4,178,000	$434,000

Referring to Figure 1, the fires which occurred in the major cotton processes are broken down further to show the various causes of fires in each process and the number in per cent caused by different classes of electric apparatus.

ELECTRICAL FIRE CAUSES

IT WILL BE NOTED that electrical and friction fires predominate in all manufacturing processes except the Opener-Picker process. The need for more attention to the electric equipment in most of the manufacturing areas is apparent. In the Opener-Picker process only 5 per cent of the fires were due to electrical causes and it is believed this is largely the result of the special efforts of our inspectors since 1940 to obtain improvements in the electric installations in these areas because this has been recognized as a particularly hazardous location. In the other processes the proportion of fires due to electrical causes varied from 23 to as much as 47 per cent.

Most of these electrical fires were the result of poor

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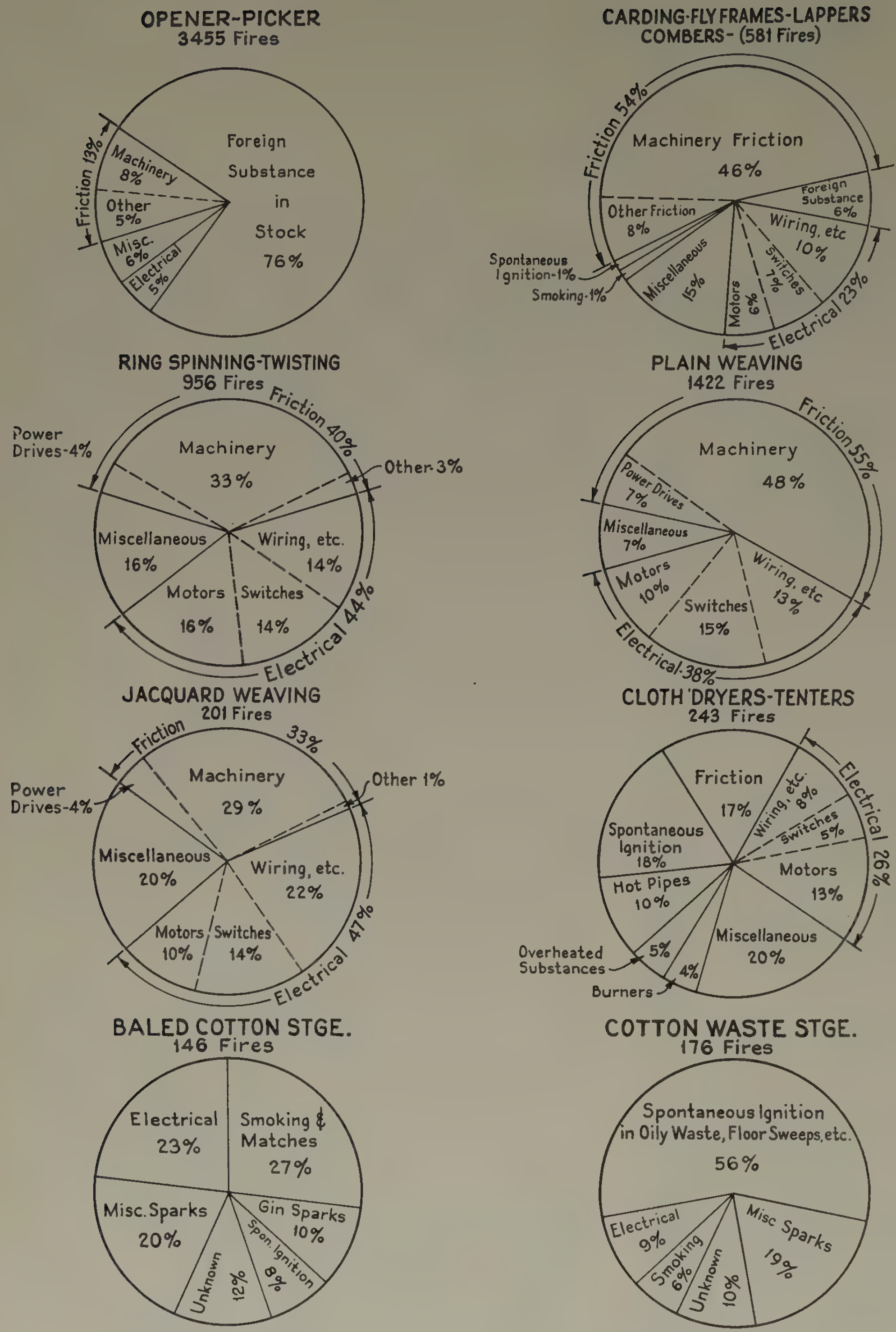

Figure 1. Fire causes in major cotton occupancies between 1940 and 1949

installation, improper or inadequate maintenance, abuse and misapplication or, in other words, poor engineering. For example, it has been the practice, until the advent of fluorescent lighting, to use unprotected incandescent lamps throughout most of the cotton mills regardless of the degree of hazard involved in the different areas. Whether they were in fixed ceiling units, pipe pendents, or cord pendents, if the lamp broke due to vibration, or to being accidentally struck, a fire frequently followed because the arcing or hot filaments ignited surrounding lint or loose cotton. This unsafe type of installation never should have been made in the first place in the very linty locations. Today when incandescent lamps are planned for such locations the vaporproof type of fixture which has a heavy glass globe surrounding the lamp is recommended and in some cases even a Class *II* Group *G* lighting fixture may be necessary. The increased use of fluorescent lighting equipment is helping this situation also.

The chart shows that a large percentage of the electrical fires are due to defects which develop in the wiring, switches, and motors. Most of the fires due to wiring defects are the result of short circuits which develop when flexible metal conduit shakes loose from its connections or is pulled loose by careless employees or becomes oil-soaked from oil dripping off the machinery. Wiring in rigid conduit also produces its share of fires when exposed to oil, moisture, abuse, and inadequate maintenance.

Switches and controllers cause many of the fires because for the most part they are not lint-tight. The enclosures for such equipment are usually the National Electrical Manufacturers Association (NEMA) Type *1* general-purpose enclosures which are definitely not lint-tight. After a switch has been in service a short time in a textile plant processing combustible fibers, lint begins to accumulate in the interior. This gets on the contacts and in the mechanism, and eventually it is ignited by arcing or heating of the contacts. Sometimes this results in a short circuit due to ionization within the enclosure, then the cover is blown open and surrounding combustibles are ignited. Occasionally the switch is mounted where it is exposed to severe vibration and the contacts burn, parts loosen up, and short circuits develop. In the case of magnetic-type starters a wad of lint may accumulate on the armature of the magnetic contactor and prevent a good contact when the contactor is in the "closed" position This may result in overheated contacts or single phasing.

Unused open knockouts and holes for mounting purposes

in the sides and backs of the enclosures for switches and controllers are another source of trouble. They permit lint and dust to enter and sparks and flames to escape.

Knockouts of the concentric and eccentric types also cause trouble. Frequently while removing the smallest knockout the larger punchings are loosened or distorted so that they are no longer tight. This may affect the continuity of the grounding system as well as permit the entrance of lint and dust and will not confine sparks or flames to the enclosure.

Many of the unused knockouts in switch enclosures unintentionally are removed or loosened by employees idly tapping them with a hammer, screw driver, spindle, or any other object they happen to have in their hands as they pass by.

The thermal-type overload relays in the motor starting switches are a source of trouble too. Frequently these are missing altogether, sometimes they are jumped, occasionally they are too large and misapplied in other ways. For example, some starters are used in group installations which are not designed for such applications. Consequently, when a short circuit occurs, the thermal overload device may fail because the branch circuit fuse is too large and the switch is destroyed as a result. Starters designed for group installations may be protected with fuses larger than four times the full-load rating of the motor with which they are used according to the National Electrical Code, but ordinary starters may be protected with fuses not larger than four times the motor current rating.

Fires caused by the motors are mostly due to overheating, resulting from overloading or clogging with lint and foreign materials, single phasing, and short circuits caused by failure of the insulation on the windings due to saturation with oil and moisture.

ENGINEERING CONSIDERATIONS

In the past it has been general practice with most of the textile machinery manufacturers to furnish their machines without the motors and controls, leaving it up to the mill to supply this equipment. Some mills also have insisted on furnishing and installing the electric equipment themselves even though the machinery manufacturer normally did supply this apparatus too. This was due to several reasons. Some mills had standardized on certain makes of apparatus and those which would have been supplied by the machinery manufacturer were of a different make. Others felt that it would be less expensive to buy the necessary equipment and install it themselves or they had spare equipment on hand or an opportunity to buy some used apparatus which they believed would be suitable. Occasionally the purchaser had a friend or relative in the electrical business, through whom he could effect a substantial savings or to whom for reasons of his own he preferred to give the business.

Experience has shown that this practice is frequently the most expensive in the long run and has resulted in difficulties of many kinds to all concerned. Fires also have occurred because the electric equipment selected was unsuitable.

In order to be sure that the proper equipment is selected, the basic physical constants of the machine must be known as well as the characteristics required in the electric equipment to afford continuous trouble-free operation. Too often the purchaser as well as the salesman is not sufficiently well informed of these details to make the proper selection. There are times too that a salesman, in his fear of losing a sale to a competitor, will sell a less expensive device that is not entirely suited for the purpose, which may get by for a while, rather than a more costly device especially built for the machine and the conditions of operation.

It is not enough to know that the motor selected to drive a machine should be rated at a certain horsepower, voltage, and speed. There are numerous other factors that must not be overlooked in making the proper application if long trouble-free life with the minimum of maintenance is to be expected. For example the speed torque characteristics of the motor selected should be known. A Class *B* squirrel-cage motor gives a "hammer-blow" start and accelerates rapidly, so naturally it cannot be applied to a machine where the repeated starting shocks are likely to result in excessive wear or mechanical damage. Slow start and controlled acceleration is necessary to eliminate starting shock in many cases, although spinning frames, combers, pickers, and opening machines are still started at full voltage using a squirrel-cage motor with high starting torque, with little if any trouble. Wool and worsted spinning frames, spoolers, roving frames, twisters, reels, and many other machines, however, usually require a slow or controlled acceleration. Some starters are arranged with a resistance in the supply line which is gradually cut out as the motor nears its top speed and allows the machine to be started slowly and smoothly, without other mechanical means, such as slip clutches, to prevent starting shock.

Woolen cards also require a smooth start, but due to the static friction they need, in addition, a very heavy torque to get them moving. This heavy torque must be applied gradually, however, because of the settings between the workers and the card cylinders being so close. Otherwise damage may result due to springing of the shafts and the card sides. Special controls and motors are available which will start and accelerate these machines with ease and with little if any trouble over the years.

Where frequent stopping and starting is required, the proper motor must be selected in order to prevent the high current and excessive losses during starting causing the windings to overheat. Class *D* squirrel-cage motors should be used for such conditions as the starting current is approximately only half as much as that of the Class *B* and *C* motors and the starting torque is 50 to 100 per cent more. Overheating of the motor is thus prevented because the heating varies as the square of the current. Therefore, if the starting current is reduced by one-half, the heating is reduced by a quarter.

These are only a few of the factors which must be considered to apply intelligently a motor and its control to a textile machine. It is obvious that a detailed knowledge of the characteristics of the machine and the electric apparatus is essential if trouble is to be avoided.

When a motor or its controls fails due to misapplication, the production of the machine which it drives ceases until repairs or replacements are made and many people are affected. The operators, if they are on piece work, are disturbed because they may suffer a monetary loss; the supervisor is required to explain to management why the production of his department is down; the electrician and the plant engineer are criticized because they are supposed to keep the wheels turning; and a customer may be lost because his order was not filled at a specified time. The electrical manufacturer is criticized because his equipment would not stand up, and reflections are cast upon the machinery manufacturer because his machine was involved.

If fire follows a breakdown in the electric equipment, as it does frequently and as attested by the loss record, it is not always confined to the unit in which it originates. Too often it spreads beyond this device and involves other machines and equipment in the same area and the physical damage and loss of production are greatly increased. All of this trouble could have been avoided by the proper application of the electric equipment at the beginning.

As mentioned previously the mechanical and electrical characteristics of the machine and driving equipment are most important and should be integrated properly by those who are best qualified to do so. Some of the larger mills have adequate engineering staffs fully qualified to perform work of this nature, other mills do not and they would be well advised to seek the advice of the textile machinery and electrical manufacturers before installing such apparatus. The fire insurance companies also should be consulted to be sure that the proper equipment is being furnished from the fire standpoint as well. Much of the equipment installed in the past has been perfectly satisfactory except from this latter viewpoint. Typical of this is the continued practice of many mills of using standard open motors for nearly all applications. In areas where there is little or no lint involved, this type of motor will give good service with reasonable attention assuming that it is otherwise properly applied, but in areas where there is a large quantity of lint normally present the same motor will require considerable maintenance to keep it clean and free of lint and in good condition. Sparks from a short circuit in the windings, or failures due to overheating resulting from clogging of the ventilating passages, friction due to accumulation of lint inside the motor, and so forth, usually result in a fire. For these very linty areas it would be far safer to use the specially built textile motor with smooth windings and large air passages designed so that the lint will blow through the motor and not accumulate within it. The totally enclosed motor is the preferred type to use because the fire hazard is practically eliminated and the maintenance is much reduced. Unfortunately, however, the totally enclosed motors are commercially available only in sizes up to and including 15 horsepower, and above 3 horsepower the frame size is often too large for the particular application.

Dripproof, splashproof, and totally enclosed fan-cooled motors are not suitable for linty occupancies as they do clog easily and require a good deal of maintenance to keep them operating satisfactorily. Despite these difficulties they are frequently installed in such locations and trouble generally follows.

Some thought is being given today by the electrical manufacturers to extending the line of totally enclosed nonventilated motors to include some of the larger sizes. In fact some already have been built with special means being provided for cooling purposes. The fire insurance companies fully endorse this line of thinking as the increased use of enclosed nonventilated motors in the textile industry unquestionably will improve substantially the loss record and from the buyers' viewpoint will reduce the maintenance requirements and minimize the interruptions due to winding failures and other motor troubles.

Most of the switches and motor controllers installed in the past in cotton mills and other textile plants have been equipped with NEMA Type *1* general-purpose enclosures. Obviously these are not lint-tight and never were intended to be, but because the only other available enclosures which could be considered lint-tight were more expensive, some excessively so, they were rarely installed. These enclosures are designated as the NEMA Type *1-A* Semi-Dust-Tight, Type *V* Dust-Tight, Type *IX* Dust-Tight Extra-Hazard Locations, and Type *XII* Special Service Dust-Tight. The semi-dust-tight designation of the Type *1-A* enclosure is actually misleading because for some applications they may be provided with ventilating openings which would permit the entrance of lint, and consequently they would not be suitable for very linty occupancies. Furthermore, they were not available for all types of starters nor for all sizes. Under the conditions, if a lint-tight enclosure were desired it would have had to be, until recently, one of the much more expensive types, such as the *V*, *IX* or *XII* and, because of the excessive costs, the mills usually ended up by installing the general-purpose enclosures.

Acknowledging the need for a better enclosure for loom switches than the Type *1*, which has contributed to so many fires, one of the electrical manufacturers several years ago redesigned his loom switch and provided it with a lint-tight enclosure. This was the result of the co-operative effort of engineers representing the machinery manufacturers, the electrical manufacturers, and the fire insurance companies. The switch was produced at a moderate additional cost, but despite this it has been so well received by the textile industry that several other makes with satisfactory lint-tight enclosures are now available.

Unfortunately lint-tight equipment is available at reasonable cost for only a small percentage of all the electric apparatus that is used in those areas where combustible lint or fibers are present in dangerous quantities. Combination-type starters are available with NEMA Type *1-A* enclosures which are a decided improvement over the Type *1*, but these may not be entirely lint-tight because of the openings in the cover for the overload reset buttons. The concept of lint-tight enclosures for all electric equipment in linty occupancies is undoubtedly the most practical approach to eliminating most of the troubles which have occurred in the past in these areas. Some progress has been made in this direction but much remains to be done.

In keeping with the trend today of various manufacturers furnishing a complete "packaged unit" to the purchaser, some of the textile machinery manufacturers are supplying a completely integrated machine which includes all the associated electric equipment so that the buyer only need bring the electric circuit to the machine and connect it to the controller to place it in operation. If the proper type of electric apparatus is provided initially and it is installed and wired in a safe manner at the builder's factory, many of the problems described previously when the electric equipment was purchased and installed separately by the purchaser will be overcome. This practice has the additional advantage from the purchaser's viewpoint in that it places the entire responsibility on the machinery builder. The latter will not object to this because he is not going to install equipment that will require frequent servicing and it will eliminate many of the service calls he has to answer today for which he actually has no responsibility. Packaged units will help the purchaser too in that he will be able to standardize on all the equipment which he uses.

At the present time the AIEE Subcommittee on the Textile Industry is endeavoring to develop standards for the enclosures that will be acceptable to all concerned. Tentative specifications have been prepared and were published a little over a year ago in trade journals and work is also underway at the moment with the assistance of some of the textile machinery builders in preparing standards for a composite enclosure that will incorporate all the desired features of safety and reliability and will fit readily into their manufacturing processes.

The use of lint-tight equipment should not necessarily be restricted to cotton mills or similar occupancies where the lint and fibers involved are readily combustible. It is also good practice to follow in those other types of textile plants where the fibers are not so combustible. By keeping the interior of the enclosures clean and free of dust and lint at all times, the equipment will last longer and give less trouble, the cost of the maintenance will be reduced, and losses due to interruption to production because of electrical breakdown will be held to a minimum.

It is recognized that the degree of fire hazard in textile occupancies varies with the combustibility of the fiber, the amount of lint produced by the particular process, and the form and amount of stock in process (for example, laps, roving yarn, cloth). Accordingly, more care must be used in the selection and installation of electric equipment in some occupancies than in others. To assist in determining the degree of hazard as a guide to the installation of the proper electric equipment the Factory Mutual Engineering Division has prepared Table I which is included in their rules for "Electrical Installations, Textile, Carpet, and Cordage Plants." This table divides the occupancies into two major divisions, Extra-Hazard Operating Areas and Moderate-Hazard Operating Areas, which are determined by the nature of the process and the combustibility of the fiber.

After determining from Table I whether the occupancy in question is an Extra-Hazard Operating Area or a Moderate-Hazard Operating Area the proper type of electric equipment that should be used (that is from the fire standpoint) may be selected readily.

Briefly, the electric equipment in these areas should be installed in the following manner.

In general the wiring should be in rigid metal conduit, except that electric metallic tubing is acceptable in the Moderate-Hazard Areas unless it is subject to severe vibration, corrosive conditions, or exposed to severe mechanical abuse. On machinery or other places where vibration may cause trouble, flexible cord with a tough oil-resistant jacket such as Type *SO* or *ST* should be used. Watertight-type connectors should be used with the cord for attaching to the various devices.

Where the wiring is exposed to oil drippings, the insulation should be oil resistant. If a flexible metal conduit is desired, there are several makes available which are provided with a synthetic oil-resistant jacket. Watertight connections also are recommended for use with this conduit and stranded wires should be used if vibration is a problem.

Table I. Classification of the Fire Hazard of Various Fibers and Processes

Fibers		Processes	
A	B	C	D
Easily Ignited, Readily Combustible, Produces Lint Freely	Not Readily Combustible, Produces Little or No Lint	Considerable Lint Production	Moderate Lint Production
Cotton	Hemp*	Opening	Ring spinning
Flax	Mohair	Picking	Twisting
Jute	Nylon (staple)	Blending	Warping
Kapok	Rayon (acetate staple)	Carding	Spooling
Orlon (staple)	Silk	Drawing, lapping, and combing	Beaming
Ramie	Sisal*	Roving operations	Slashing
Rayon (viscose staple)	Wool	Mule spinning	Weaving, plain and dobby
Fibers similar to any of the above	Fibers similar to any above	Heavy twisting	Jacquard weaving of continuous filament
Rope, burlap, bagging, wool shoddy and similar waste fibers to be reworked		Jacquard weaving of staple fibers	Shearing
		Plush weaving	Knitting of continuous filament
		Carpet weaving	Singeing
		Napping	Printing and calendering
		Garnetting	
		Waste recovery and handling	
		Lap storage	
		Fiber stock bins	
		Bat making	
		Knitting of staple fibers	
		Drying	
		Flock printing	

Extra-Hazard Operating Areas are those where Fibers A (either alone or in blends with each other or with Fibers B) are worked in Processes C.

Moderate-Hazard Operating Areas are those where Fibers A (either alone or in blends with each other or with Fibers B) are worked in Processes D; or where Fibers B are worked in Processes C or D.

Processes using continuous-filament fibers of rayon, orlon, nylon, vinyon, velon, saran, and silk do not produce lint and do not require special electric equipment.

*Hemp and sisal though readily combustible produce little lint.

Bus duct should not be installed in the Extra-Hazard Operating Areas but nonventilated lint-tight bus duct is acceptable in the Moderate-Hazard Areas.

All spark-producing equipment, such as controllers, switches, fuses, and circuit breakers should be in lint-tight enclosures, in both the Extra-Hazard and Moderate-Hazard Areas. Attachment plugs and receptacles should be of the type that either will break the circuit before the plug can be removed or confine the arc when the circuit is broken so that surrounding lint will not be ignited.

Motors whenever possible should be of the totally enclosed nonventilated type. Otherwise the self-cleaning or lint-free types of textile motors should be used. Open-type nonsparking induction motors are acceptable only where there is normally very little lint or dust.

Lighting equipment should be fixed ceiling or wall units or pipe pendant fixtures. Pipe pendants should have spring-supported hangers or swivel joints to reduce the damage if the fixture is accidentally struck. Incandescent lamps should be provided with vapor-tight or dust-tight globes or covers in the Extra-Hazard Areas and they should not be installed in fiber stock bins or dryers. Lamp sockets should be the heavy-duty keyless type. In the Moderate-Hazard Areas outer globes are not required for fixed overhead lights. Those installed under looms should have dust-tight or vapor-tight outer globes.

Hot-cathode fluorescent lights are acceptable in the Extra-Hazard Areas provided the ballasts are enclosed and the upper part of the fixture enclosing the ballasts and the wiring has no openings in it whatever through which lint can enter or fire escape and the lamp starters are the type that will prevent the ballast from overheating due to the repeated attempts of the starter to light a deactivated lamp. In the Moderate-Hazard Areas ordinary open-type fluorescent fixtures may be used for overhead lighting.

Oil-filled transformers should be located outside or in separate noncombustible vaults. The sealed dry-type or the askarel-insulated type may be installed inside but should not be installed in the Extra-Hazard Operating Areas. Ventilated dry-type transformers are not suitable for installation in areas where there are combustible lint and fibers normally present.

Great care should be given to the design and installation of electrically energized materials handling, and textile cleaning, systems and equipment to control the potential fire hazards inherent with the equipment. More and more apparatus of this type is being installed today, because of the great savings that can be effected in time and labor costs and unless it is safely arranged, severe fire hazards can be introduced.

This apparatus often incorporates bare-contact conductors with monorail-type conveyor systems. The contact conductors preferably should be enclosed or otherwise arranged so that short circuits and grounds will be unlikely to occur and two current collectors should be used on each contact conductor to eliminate or reduce sparking at the collectors when they pass joints, rough places, lint or foreign materials on the contact conductors. Some electrically energized lap-handling systems and automatic cleaners for removing the lint from the monorails and under spinning frames and from overhead equipment and so forth already have been installed using bare-contact conductors. A few fires have occurred from this apparatus but the record thus far is generally good, apparently because the cleaning systems do not allow the lint to accumulate. The sliding type of current collector needs periodic inspection so that it may be replaced before it becomes seriously worn. All switches and controllers should be provided with lint-tight enclosures. Where flexibility is needed at motor leads and so forth, heavy-duty oil- and moisture-resistant flexible cords should be used, such as type *SO* cord or the equivalent.

Hoisting motors should be arranged so that they cannot swivel more than 180 degrees. In one case the motor was permitted to turn 360 degrees and as a result the leads short-circuited and a fire occurred in baled cotton.

The application of these fundamental considerations by the textile machinery builder, the electrical manufacturer, and the purchaser when electric equipment is constructed for or installed in textile occupancies cannot fail to produce a much more safe and trouble-free installation than generally has been provided heretofore.

Core Designed for Small Power Transformers

A precut, preformed core for small power transformers that improves performance and reduces transformer size and weight has been announced by the General Electric Company. This core, made of oriented, cold-rolled silicon steel, provides greater flexibility in designing some of the important characteristics of a transformer. The losses, exciting current, noise level, weight, and dimensions can be varied to suit operating conditions.

This is done by using a minimum number of joints, an annealing process which removes mechanical strains introduced when the core is formed, and a unique clamping structure.

In manufacturing the core, cold-rolled steel laminations are cut in progressively decreasing lengths by an automatic shear and are then stacked into a ring. A hydraulic press forms the ring into a rectangular shape. After being securely banded in this shape, the core section is annealed in an electric furnace to fix its shape permanently and to remove strains. In the final assembly, two core sections are bolted together and supported in a special clamping structure designed to prevent strains on the laminations.

The steel used in the cores, called Corisil, required the development of the low-strain efficient magnetic circuit of the preformed core to take full advantage in power transformers of the highly directional properties of this steel.

These cores are used in Spirakore distribution transformers which are built in all single-phase ratings 5,000 kva and below.

Square-Loop Core Magnetic Amplifiers

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THIS ANALYSIS APPLIES to magnetic-amplifier circuits of the center-tap, bridge-type, or a-c variety. Such circuits are called amplistats, Magamps, transductors, self-saturated magnetic amplifiers, and so forth. Figure 1 shows the circuit diagram of the center-tap connection. The amplifiers under discussion are of the so-called low control-circuit impedance type. In order to reduce the complexity of the analysis, many simplifying assumptions are made. While these assumptions introduce inaccuracies in the equations, the latter still serve effectively in establishing first-order relations among the variables. A large part of the analysis is applicable to core materials whose dynamic *B-H* loop is not strictly rectangular, such as grain-oriented silicon steel.

The load current I_L consists of the exciting component $I_{L,x}$ and the saturation component $I_{L,s}$, and hence the control characteristic (Figure 2) can be synthesized of two components.

Let $\mathfrak{i}_C$ denote the per unit control current

$$\mathfrak{i}_C = \frac{I_C N_C}{H_c l_{Fe}/0.4\pi} \tag{1}$$

and $\mathfrak{i}_E$ the per unit exciting current

$$\mathfrak{i}_E = \frac{I_E}{I_{L,m}} \tag{2}$$

The per unit saturation component $I_{L,s}/I_{L,m}$ becomes a cosine function of the control current (Figure 2*A*) and the per unit exciting current component $I_{L,x}/I_{L,m}$ becomes a linear function of the control current (Figure 2*B*). The sum of both functions represents the control characteristic. With cores deviating from the assumptions, the control characteristic is unaffected in the vicinity of $\mathfrak{i}_C = -1$, but the upper part of the characteristic may shift to the right or left.

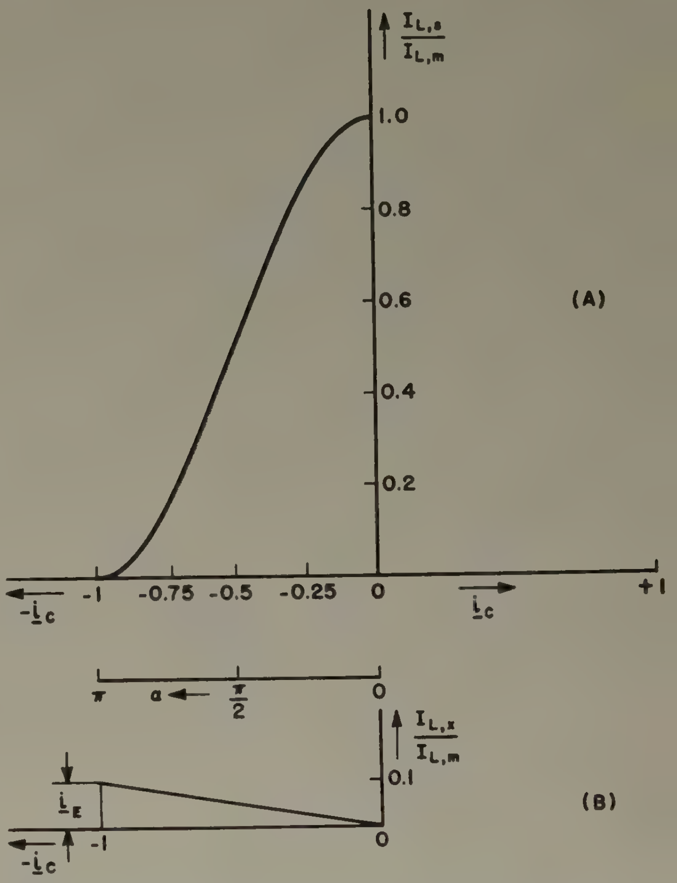

Figure 2. Synthesis of control characteristic. (A) Per unit saturation component of load current. (B) Per unit exciting component of load current versus per unit control current

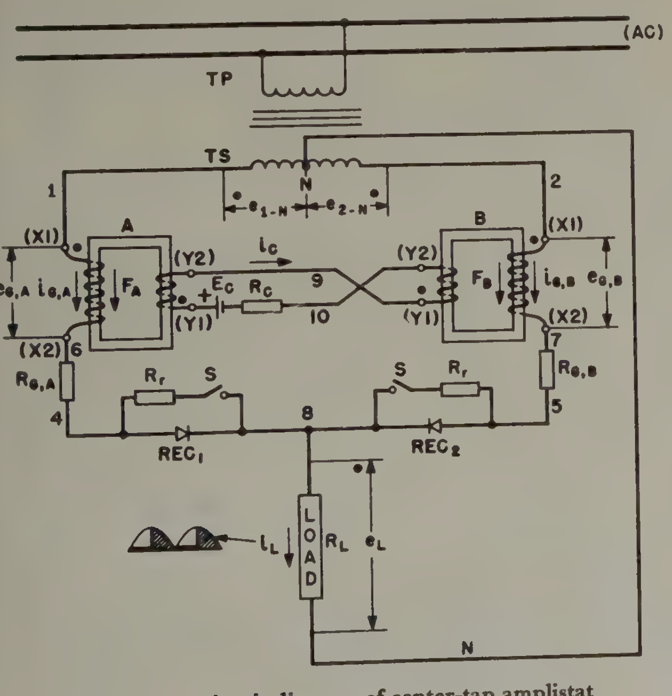

Figure 1. Circuit diagram of center-tap amplistat

With reverse current present in the rectifiers REC_1, REC_2, the control characteristic of Figure 2 becomes sheared to the right.

The time constant is proportional to the slope of the curve in Figure 2*A*; the time constant is inversely proportional to the exciting current $\mathfrak{i}_E$ of the saturable reactor. The ampere-turn gain and the dynamic power gain are inversely proportional to $\mathfrak{i}_E$. The power gain is inversely proportional to $\mathfrak{i}_E^2$. The dynamic power gain is inversely proportional to the coercive force H_c of the dynamic hysteresis loop, and hence, inversely proportional to the width of the dynamic hysteresis loop.

Digest of paper 53-284, "Theory of Magnetic Amplifiers With Square-Loop Core Materials," recommended by the AIEE Committee on Magnetic Amplifiers and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Summer General Meeting, Atlantic City, N. J., June 15–19, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

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Branch-Circuit Overcurrent Protection for Appliance Loads

F. G. VON HOORN

Three typical branch circuits and their protective devices are examined. These are the general-purpose lighting and appliance branch circuits, the special branch circuits supplying a single fixed appliance, and motor branch circuits.

IN ADDITION TO the overcurrent protection afforded appliances by component means in other articles in this series, it is necessary, for a complete understanding of the subject, to consider the important role of the branch-circuit overcurrent protection and its relation to the satisfactory performance of electrically powered appliances. Frequently, this protection, required by the National Electrical Code, is the only overcurrent protection ahead of the appliance.

Throughout the United States and Canada it is a standard requirement that branch circuits providing for the connection of either portable appliances by plugs and outlets, or fixed appliances through permanent connection, be equipped with suitable overcurrent devices to protect the circuit conductors. Fortunately, in all of the many deviations existing at the local level, there is no known relaxation of the requirement for adequate branch-circuit overcurrent protection where circuits supply appliances. In view of this widely accepted practice, therefore, it devolves upon the appliance designer to inquire into the characteristics of the circuit to which his appliance may be connected and to explore the nature of the protection which is afforded thereby.

GENERAL-PURPOSE LIGHTING AND APPLIANCE BRANCH CIRCUIT

THIS TYPE OF CIRCUIT supplies lighting outlets and convenience outlets in industrial, commercial, and residential occupancies. It is rated 15, 20, 30, or 50 amperes and no conductor of such circuit may exceed 150 volts to ground, except for certain higher voltage lighting installations under controlled conditions and certain portable appliance loads. The National Electrical Code (NEC) requires for dwelling occupancies that at least one such circuit of number *12* wire (20 amperes) be installed in the kitchen, laundry, and dining areas for the connection of appliances. Such circuits are in addition to those required by the code for lighting and electric appliances in all other areas.

The circuits, most generally rated at 15 or 20 amperes, are required to have overcurrent protection equal, within appropriate tolerances, to the circuit rating. The protection may be, optionally, either plug or cartridge fuses of NEC dimensions or branch-circuit circuit breakers. These devices will protect the conductors of the branch circuit against fault currents ranging from overloads to short circuits regardless of whether the fault occurs between conductors or between a conductor and ground.

To qualify for listing, branch-circuit protective devices must comply with published "Standards of the Underwriters' Laboratories," which, together with other requirements, specify conditions of test for short circuit, and limits of performance on overload.

According to these standards, a fuse shall be capable of carrying 110 per cent of its rated current indefinitely and shall blow on 135-per-cent rated current within 1 hour. On 200 per cent of rating the limit is 2 minutes for fuses rated 0 to 30 amperes, and 4 minutes for fuses rated 31 to 60 amperes.

For circuit breakers rated 50 amperes or less, the limits are slightly different. A breaker shall be capable of carrying 100 per cent of rated current indefinitely, and shall trip automatically on 125 per cent of rated current within 1 hour. On 200 per cent of rated current the limits are 2 minutes for devices rated 0 to 35 amperes, and 4 minutes for devices rated 36 to 50 amperes.

Since the rating of an appliance seldom matches exactly the rating of the branch circuit to which it is connected, it is apparent that separate provision must be made to handle the appliance overloads. However, because of the fact that the branch-circuit overcurrent device inherently has the capacity for handling fault currents of short-circuit magnitude regardless of whether the fault occurs in the appliance, the appliance connection, or in the branch-circuit conductors, the means provided for handling the appliance overloads need have only overload capacity, and therefore may be auxiliary in character. For this reason, the appliance overload device can be relatively simple and inexpensive and may be built into the appliance or provided as an accessory without undue complication. Care must be taken of course to make certain in all instances that the appliance overcurrent protection has the ability to withstand the high fault currents long enough for the branch-circuit protective device to clear the circuit. Quite

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naturally, the Underwriters' Laboratories tests have been framed carefully to include checks for this condition.

To minimize service calls, any necessary appliance overload protection should be of an obvious nature, preferably of a readily resettable or replaceable type, and should be installed in an accessible location.

SPECIAL-PURPOSE BRANCH CIRCUITS

These circuits differ from general-purpose branch circuits in that they supply specific appliance loads and therefore may have overcurrent devices selected on a basis of the full-load rating of the appliance. In a water heater circuit, for example, the branch-circuit overcurrent device may have a current rating only slightly above the full-load current rating of the water heater and in this way it is able to provide adequate overcurrent protection for both the appliance and the branch-circuit conductors.

Similarly, ranges and other fixed appliances having straight resistance loads do not require, and seldom have, electric overcurrent devices that function on overload in the appliance.

MOTOR BRANCH CIRCUITS

With the growing popularity of complete air-conditioning systems in the home the third type of circuit, or motor branch circuit, assumes particular significance. The code of course furnishes complete tables stipulating minimum conductor sizes, and maximum allowable ratings or settings of branch-circuit protective devices and devices designed to furnish motor running protection for all general conditions.

It also provides that motor branch-circuit overcurrent protection and motor-running overcurrent protection may be combined in a single overcurrent device if the rating or setting of the device complies with the provisions of Section *4322* of the code in respect to running overcurrent protection.

In the case of manually started motors rated 1 horsepower or less, and within sight from the starter location, the code additionally provides that such motor shall be considered as protected against overcurrent by the branch-circuit overcurrent device if the rating of this overcurrent device does not exceed the limit which is specified in the motor tables.

For circuits involving motors the objectives in respect to requirements for safety are essentially the same as for other types of circuits, namely, the provision of adequate protection against all conditions involving fault currents. For motor circuits, however, the problem is primarily concerned with the thermal co-ordination of the motor, its control, and the branch-circuit conductors and the prevention of excessive temperatures in these components.

When the overload relay of the motor serves the dual functions of protecting both the motor and the branch-circuit conductors from operating overloads, the branch-circuit protective device may exceed within appropriate limits the size normally required for the protection of the conductors without in any way deviating from the general objectives.

When conventional one-time NEC cartridge fuses are used to provide the branch-circuit overcurrent protection in combinations similar to that described, they probably will be rated at about three, but not more than four, times the motor full-load current for across-the-line starting, in accordance with NEC Table 20. The ratio is about the same when regular thermal branch-circuit circuit breakers are used. Standard fuses are low in cost and replacements are available almost everywhere. They are relatively fast on interruption, but are sensitive to overload. Circuit breakers of course are dead front, and have the advantage of an integral disconnecting means. Caution always should be exercised in the application of circuit breakers which incorporate instantaneous magnetic trip.

By using fuses having a built-in time-delay feature for overloads, the rating required to provide for starting usually will be lower than for the devices discussed in the foregoing. In some instances, this means also that fuses will be smaller physically, and when such is the case, it is possible to effect a saving in the cost of the installation by employing the smaller time-delay type together with appropriate fuse holders and fused disconnecting switches.

If dual-element fuses are used for motor branch-circuit protection, the opportunity for size reduction is further increased. Because of their extremely long time delay these fuses more nearly match the motor characteristic and ratings may be selected that are very close to the actual full-load current rating of the motor. The rating and size reductions provided through their use have the effect of reducing melting time on short circuit and increasing the factor of safety for this operation.

Finally, with the introduction of the high-interrupting-capacity current-limiting dual-element fuse, opportunity is afforded for the protection of motor branch circuits in areas which were not heretofore covered by conventional means.

SUMMARY

1. Branch-circuit overcurrent protection, in some approved form, is a mandatory requirement on all branch circuits supplying appliances.
2. As a minimum requirement, the branch-circuit overcurrent device must be capable of protecting the circuit and its components against short-circuit currents and dangerous overloads.
3. For fixed appliances having nominally straight resistance loads, complete protection is usually afforded by branch-circuit overcurrent devices meeting minimum requirements.
4. Where motor-driven appliances are concerned it is usually necessary for complete protection to provide the appliance with an appropriate auxiliary means that operates only on overload, selectively with an approved branch-circuit overcurrent device that provides short-circuit protection.
5. Approved branch-circuit protective devices having interrupting abilities considerably above those necessary for approval are available when required by unusual conditions.

Co-ordinating M1 and N1 Telephone Carrier Systems

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THE BELL SYSTEM's new *N1* carrier system is a low-level cable carrier system providing 12 4-wire telephone channels in the frequency range of 44 to 260 kc. Because of its low levels, the *N1* system is particularly susceptible to interference from other existing carrier systems with overlapping frequencies and higher energy levels.

The *M1* and *N1* systems are similar in that they are both double-side-band carrier-transmitted systems, using different bands of frequencies for the two directions of transmission. Figure 1 shows the frequency allocation of the two systems and indicates their relative transmitting levels.

The loss in the *M1* to *N1* coupling path required to prevent excessive interference in the *N1* channels is nominally about 125 decibels, depending on the level of the *N1* channels at the input to the high-group receive equipment. At these frequencies the *M* energy crosstalks to the *N* facilities on a longitudinal basis, and unfortunately the longitudinal loss through an office is rather low. When *M1* equipment is pole-mounted on an open-wire line that feeds an office that contains *N1* high-group receive equipment, it is expected that the loss in the longitudinal *M* to *N* coupling path will be about 15 to 30 decibels less than required, depending, as in the foregoing, on the input level of the *N1* system and the length of the open-wire entrance cable.

Since replacing the *M1* systems with some other type of open-wire carrier system is costly, considerable effort has been directed towards the development of *M1* carrier frequency suppression devices. It has been found that where the open-wire lead does not have more than three or four arms, and where the runaround paths that would by-pass suppression units are not important, it is possible to obtain economically the additional 15 to 30 decibels of longitudinal loss by means of suppression units. The choice of the type of suppression unit is dependent on type of facilities used on the open-wire line, since all frequencies below the *M1* band must pass through the suppression units. Bell System suppression units have been designed for voice-frequency and 30-kc carrier lines. When these units are used in an open-wire line they materially increase the reflected near-end crosstalk of carrier channels operating above 30 kc.

The *F1100* filter was developed by an outside manufacturer to the telephone company's specifications in order to overcome the difficulties of operating high-frequency carrier systems through *M1* suppression units. The *F1100* filter is a high-low pass filter with a cutoff frequency of 175 kc. The mid-points of the shunt elements of the low-pass section are arranged for grounding in order to provide longitudinal as well as transverse suppression.

In most locations where *M1* to *N1* conflicts exist, it will be possible to retain the existing *M1* channels without interference to the *N1* systems by moving the *M1* equipment to a place on the open-wire line where the runaround paths are a minimum and by placing the proper type of suppression in the open wire between *M1* equipment and office.

Digest of paper **53-225**, "Co-ordination of *M1* and *N1* Telephone Carrier Systems," recommended by the AIEE Committee on Wire Communications Systems and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Summer General Meeting, Atlantic City, N. J., June 15–19, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

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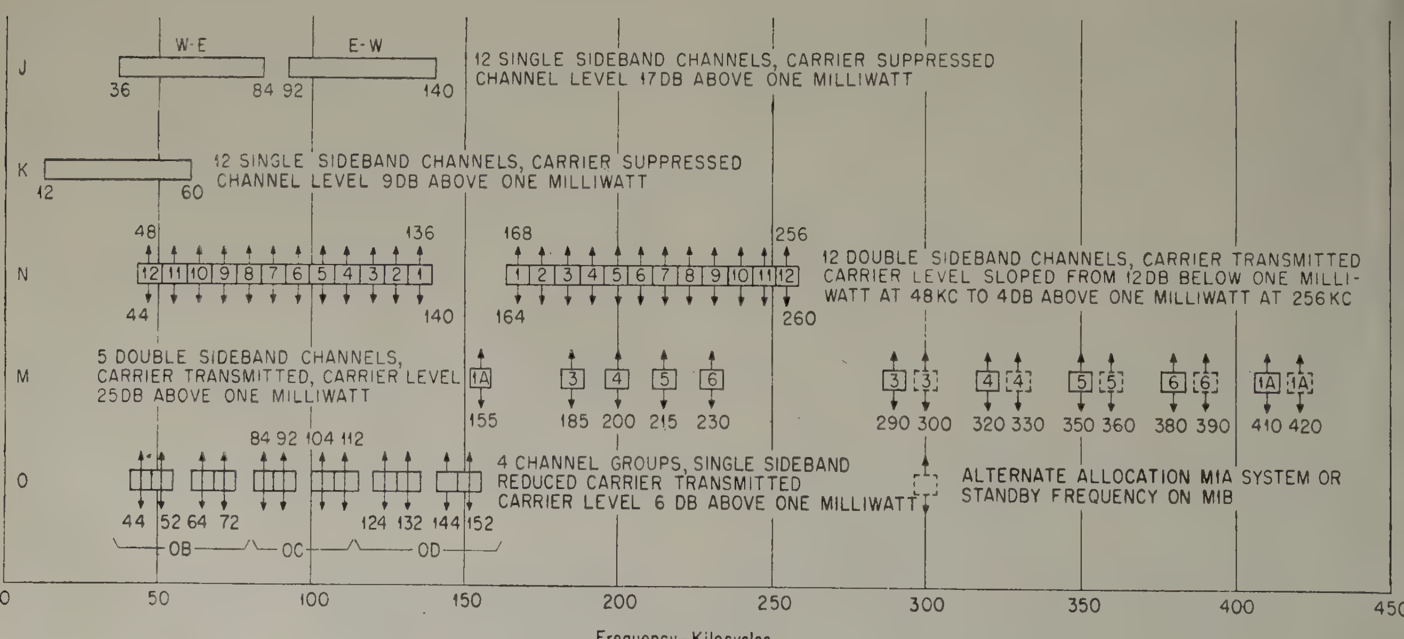

Figure 1. Frequency allocation

Natural Frequencies of Coils and Windings

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KNOWLEDGE OF THE NATURAL frequencies of air-core and iron-core coils and of transformer and generator windings is of essential theoretical and practical importance. The transient response of coils and windings subjected to impulse waves has been determined in the literature by two different methods, the "standing wave" and the "traveling wave" approach. The values of the natural frequencies enter into the analytical expressions of both these methods of calculation.

A distributed winding has an infinite number of natural frequencies. In practice the knowledge of a limited, relatively small number of these frequencies is sufficient. It is convenient therefore to represent the distributed winding by an equivalent circuit of a finite but sufficient number of concentrated elements. The number of elements to be used in the equivalent circuit depends upon the number of frequencies and upon the accuracy required. The following theorem holds:

For any uniform winding of N' elements $(1<N'\leqslant\infty)$ there exists an equivalent circuit of $N>N_o$ $(N_o<N')$ elements such that the difference between the nth $(n<N_o)$ natural frequencies is always $\epsilon\leqslant\epsilon_o$ that is, less than a pre-established value.

The losses in the winding and in the capacitances, while they have considerable effect on the amplitudes of oscillation, reduce the natural frequencies only by small amounts. It was assumed therefore in this study that the effect of the losses on the calculated natural frequencies could be neglected.

In order to obtain correct values of the natural frequencies, it is necessary to include mutual inductances between all elements of the equivalent circuit. Thus there will be nine different mutual inductances M_1 to M_9 in a 10-element equivalent circuit. This can be seen in Figure 1 where L is the self-inductance of each element and c_g the capacitance to ground.

This equivalent circuit was solved (1) by punch-card equipment and (2) by setting up an appropriate circuit

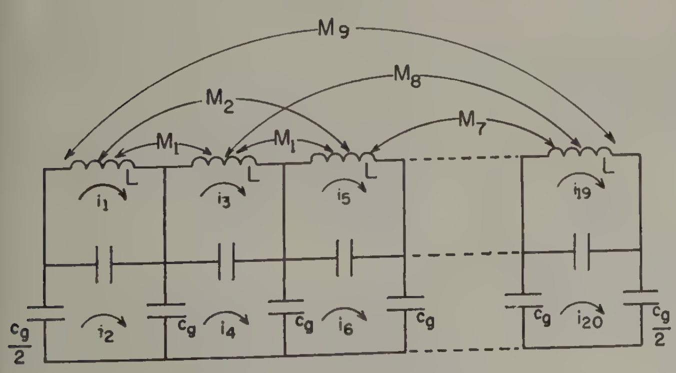

Figure 1. 10-element equivalent circuit

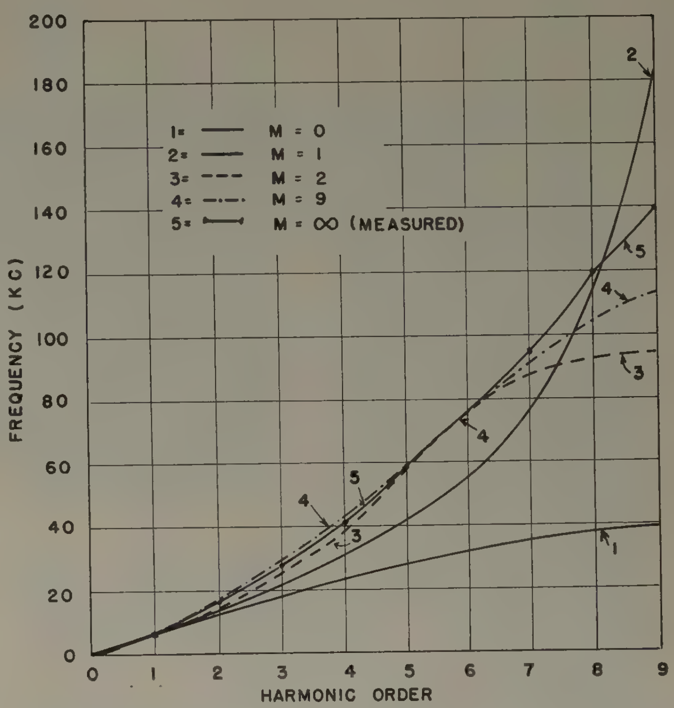

Figure 2. Effect of mutual inductance on the natural frequencies of an air-core coil (M = number of successive mutual inductance linkages included in the equivalent circuit)

on the a-c network analyzer. Both methods of solution are sufficiently accurate for practical purposes. The a-c network analyzer method is somewhat faster and changes in the circuit parameters can be made readily.

Natural frequencies of a 1,800-turn coil with air and iron core were computed in this manner. The results for the air-core coil are shown in Figure 2 where curve *4* (computed values) should be compared with curve *5* (measured values). The first seven computed natural frequencies are in excellent agreement with the measured frequencies.

Mutual inductance linkages usually are neglected in similar equivalent circuits of coils and windings described in the literature. In order to establish the accuracy of such circuits, which lead to simpler calculations, the equivalent circuits were set up for the same air-core coil, (1) without mutual inductances, (2) with mutual inductances only between adjacent elements, (3) with mutual inductances between adjacent elements and between elements separated by one element. The results are shown in Figure 2, curves *1* to *3*. It is clear that mutual inductances always should be included in the computation of the natural frequencies of coils and windings.

Digest of paper 53-133, "Natural Frequencies of Coils and Windings Determined by Equivalent Circuits," recommended by the AIEE Committee on Transformers and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 19–23, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

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Automatic Control System With Provision for Scanning and Memory

N. H. YOUNG

The development work on which this article is based was sponsored by the Bureau of Ships, United States Navy Department. This system adjusts a control element to produce a maximum or minimum value of a resulting parameter. The control element is scanned through its entire range of adjustment and returned to the position resulting in the desired maximum or minimum effect. In a system where maxima or minima are present, the tuning equipment reliably selects the largest. The apparatus required is simple and easily understood, and can be maintained by relatively unskilled personnel.

IN AUTOMATIC control systems it frequently is desired to adjust a control element to produce a maximum value* of a resulting effect. Systems sensitive to the slope of the effect are common, where the sensitive element of the system examines the slope of the curve at the point where it happens to be resting when the tuning cycle begins, and adjusts the control element to increase the result. Such systems reliably determine the peak of any curve having only one maximum, and having no points of such low slope that the system cannot determine the proper direction of motion to correct.

In the system described in this article, these limitations are not present. The system will accommodate response curves having more than one peak; in such cases the system will adjust the control element to the highest peak within the range. In addition, the system will operate correctly with curves having long, relatively flat sections within which the slope, if any, is so small as to be indeterminate. Curves of this type often are found in tuning radio transmitters and receivers. Secondary responses are produced occasionally by harmonics or image responses, and in receivers the system may be used to select the strongest of several competing signals, where desired.

The sequence of operation is exactly like the operations performed by a careful human operator in tuning an equipment having the type of response described. Such an operator, when asked to readjust the system to tune to a new response point, would adjust the control element throughout its entire range, noting the amplitude of any peaks observed, then returning the control to the position producing the highest response. The automatic system proposed, which here is called the "memory-scanning" system, follows exactly this procedure.

The elements of this system are shown in Figure 1. The postulated response curve of the controlled device is shown as the solid line in Figure 2. The input to the sensitive element of the control system is assumed to be a unidirectional voltage of varying magnitude. When a tuning cycle is initiated, the controlled element is moved to one end of its range, say position *100* in Figure 2. During this time the switch *S* in the system shown in Figure 3 is in position *1*, short-circuiting the memory capacitor (or condenser) *C*. When the controlled element has reached the end of its range, a limit switch is operated, causing the switch *S* to go to position *2*, and causing the motor to move the controlled element through its entire range, say to position *0* in Figure 2. During this scan the signal representing the response of the controlled element is being impressed through a diode *D* on the memory capacitor *C*. The potential on this capacitor will rise when the input signal rises, but will not be able to drop when the input signal drops because of the unidirectional conducting properties of the diode *D*. Thus the potential on the memory capacitor will follow the dotted lines in Figure 2, and at

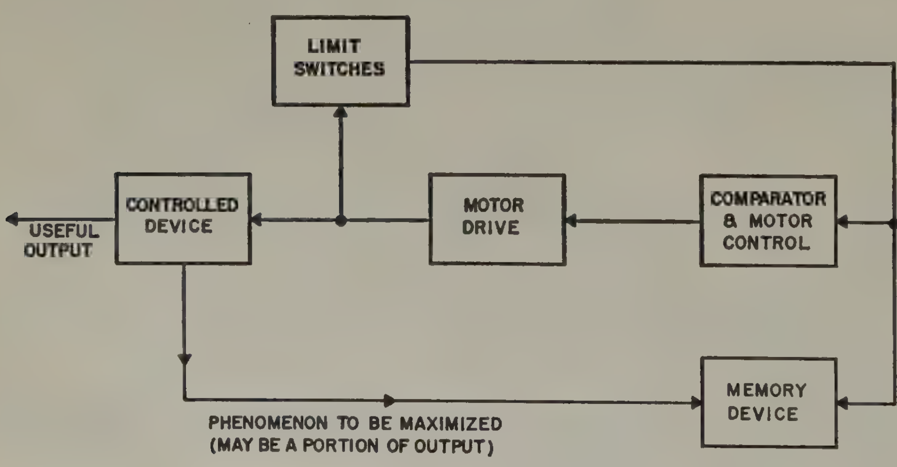

Figure 1. Block diagram of the system

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* A minimum value also may be used; throughout this article maximum only will be used for simplicity of expression.

the end of this memory scan, will be equal to the highest potential the input signal had reached during the scan.

At the end of this scan another limit switch operates, causing the switch S to be advanced to position 3. In this position the memory capacitor is connected to one of a balanced pair of tubes, while the instantaneous input signal from the controlled element is applied to the other tube of the pair. The motor also is caused to begin to return the controlled element to the other end of its range. At the instant that the potential delivered by the controlled element equals the remembered potential stored on the memory capacitor C the signals applied to the two tubes will be equal, and their plate potentials will be equal. Necessary adjustments to effect such balance initially are assumed. A sensitive relay connected from plate to plate thus will release just at the time this balance is achieved. This relay is arranged to stop the motor moving the controlled element. Thus the controlled element is stopped just at the point giving the maximum value of the desired effect.

Practical design points affecting the accuracy of the foregoing statement are evident by examination of the system. In the first place, if exact matching of potentials is required to effect stopping of the motor, even a minor change in sensitivity of the system between the memory scan and the final tuning scan might prevent the motor from stopping. Secondly, if the motor stopping impulse was initiated at the moment of perfect tuning, there inevitably would be some overshooting of the moving parts of the system, introducing errors of setting. Fortunately these two effects may be balanced against each other to a degree which depends principally on the speed of tuning operation required. For example, if it is possible to take a long time for the final scanning operation, the time of action of the relays involved and the time to operate an electromagnetic brake to clamp the motor shaft will be negligibly short. In this case, almost exact matching of potentials will be desirable. If instabilities of the phenomenon being adjusted make accurate match difficult, it may be desirable to cause the system to stop when the instantaneous voltage is equal to only 0.8 of the remembered voltage, and possibly introduce an intentional time lag in the application of the braking force, so that the normal stopping position of the system will be very near the peak. In other cases, where the time available for the tuning cycle is very limited, it may be necessary to anticipate the point of balance as indicated in the foregoing especially in order to allow time for the motor stopping action. If necessary the motor speed may be reduced for the final scan to increase the accuracy of adjustment. By suitable choice of design factors, a wide range of applications may be accommodated.

One of the principal advantages of this system is the simplicity of the theory of operation, and its similarity to the actions of a human operator. This makes it possible for the usual technicians to understand fully what is going on, and to feel confident in maintaining and trouble-shooting the equipment. No knowledge of the effects of phase on servomotors is required. No vacuum-tube amplifiers are needed. The drive motors may be of conventional types, either alternating or direct current, with no unusual problems of checking torque or maintaining slip rings. There is no direct limit to the size of drive motors or the power that may be applied to the controlled element. However, some inertia problems will become apparent in larger sizes of apparatus.

One embodiment of this principle that has reached production is the automatic tuning of the amplifier stages of a radio transmitter after the exciting frequency has been determined. One important advantage of this system over older systems having mechanical memory of the positions of shafts is in the indefinitely large number of predetermined channels that may be tuned. Any input frequency may be used, without regard to whether it ever has been set up before. Once the input is provided, the automatic system will resonate each of the amplifier stages to the proper frequency quickly and accurately.

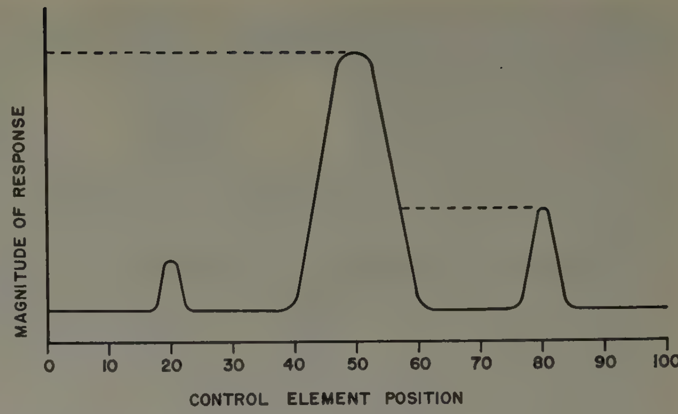

Figure 2. Assumed response curve of a typical controlled element

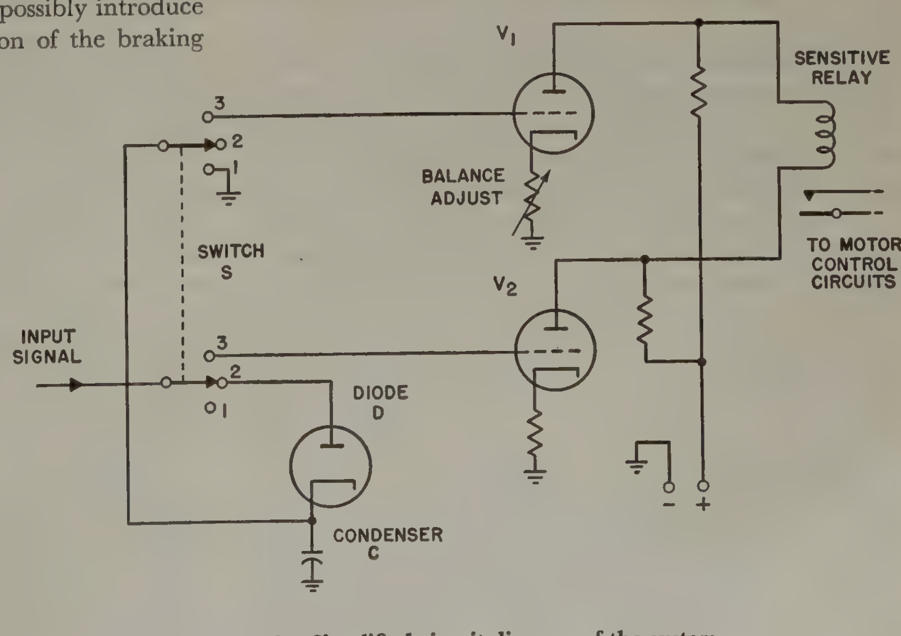

Figure 3. Simplified circuit diagram of the system

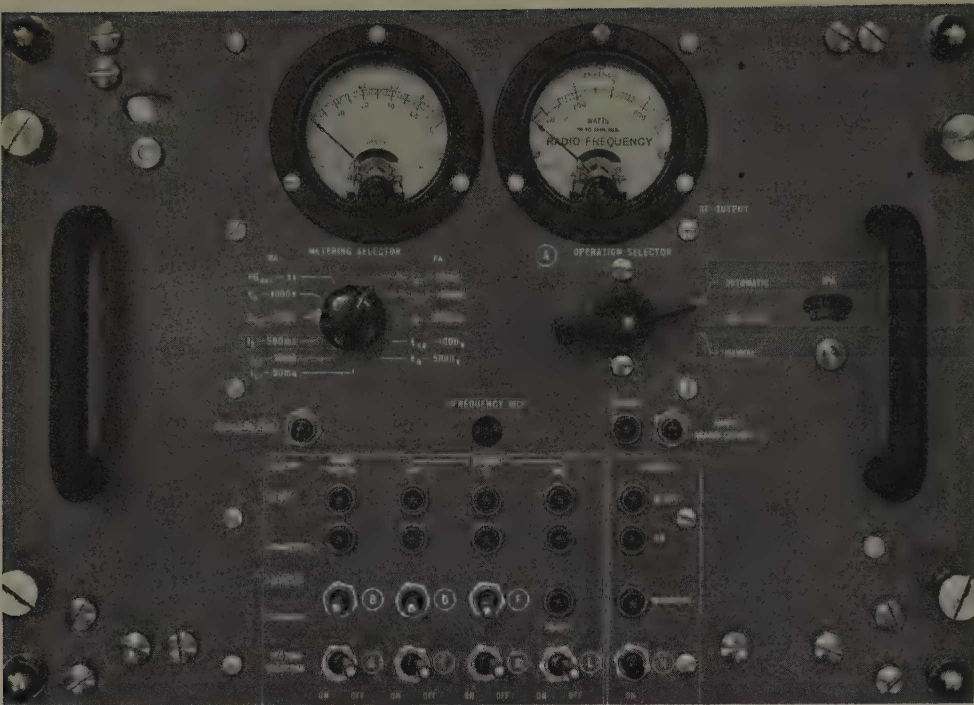

Figure 4. Front panel of radio-frequency amplifier of transmitter embodying the system

The front panel of the radio-frequency amplifier section of this transmitter is shown in Figure 4. It will be noticed that there are no tuning controls in the usual sense. The knobs shown are for switching the panel meter to the proper circuits, and for limiting the fully automatic action of the tuning system to slow down its tuning cycle for simpler analysis of troubles and for corrective maintenance. Jog switches also are provided to tune the circuits if the automatic system should fail, but they are not used normally.

Two separate cycles of the foregoing automatic tuning procedure are employed in this application. One motor drives the two low-level amplifier stages, which are ganged to a common shaft, while another motor drives the output amplifier which supplies approximately 500 watts to a special automatic antenna resonating system. The final amplifier cannot be ganged to the low-level stages because of the reaction of the antenna system on its resonance point. The tuning cycle for the smaller unit driving the low-level stages requires approximately 6 seconds, while that of the higher powered stage requires from 8 to 14 seconds depending on the frequency band the equipment utilizes.

The system described leads to simple, easily maintained equipment, capable of setting any adjustable control to the point in its range producing a maximum (or minimum) of the effect desired. It is capable of an indefinitely large number of settings, depending on the input conditions. If the phenomenon being adjusted is susceptible to drift with time, repeating the tuning cycle will readjust to the new correct position. Its low cost and applicability to a wide range of effects make it a valuable tool in the automatic adjustment of complex equipment.

World's Largest Mine Locomotive Reduces Costs, Ton-Miles

A self-contained main-line haulage unit comprising two 20-ton locomotives powered by 37 tons of storage batteries, the world's largest underground battery-operated haulage unit, has been installed by Olga Coal Company, a Youngstown Sheet and Tube Company mining operation.

The entire unit consisting of two 20-ton Jeffrey Haulage Locomotives and two power cars housing 625 kilowatt-hours of Gould batteries is over 100 feet long. The unit stands less than 4 feet off the rails.

Preliminary tests of the original unit have proved the success of the design and the complete feasibility of battery-powered main-line haulage under the conditions at Olga Coal Company so that more units are under construction.

Both driving sections of the locomotives are operated by remote control as a single unit and the locomotive operator can handle the entire unit from either end. Each driving section is equipped with two independent braking systems. The one system comprises standard air brakes and the other system uses dynamic braking with the electric motors operating as generators feeding back into a resistance load.

A special type of battery, consisting of 120 cells, 240 volts, furnishes electric energy sufficient to supply current up to the maximum rate of 1,600 amperes and will operate the unit for a full 8-hour shift. Duplicate batteries are used with each haulage unit so that one battery is put on charge at the end of the shift and a fully charged battery is hooked into the circuit for the start of the next shift. The batteries are charged by constant potential rectifiers starting at a rate of 650 amperes and finishing at 130 amperes.

The haulage unit is used at Olga Number 1 mine at Coalwood, W. Va., in a seam which runs 78 inches high. Production at this mine approximates 5,000 tons per day.

Completed engineering studies based on the successful operating experience of the first unit indicate that this mammoth haulage unit and high-capacity battery will produce lower main-line haulage costs by decreasing the number of trips per shift and increasing the amount of coal handled per trip.

D-C Dynamic Braking of Induction Motors

W. A. LaPIERRE
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N. METAXAS

A THOROUGHGOING RATIONAL method of calculating the braking torque to be expected from squirrel-cage motors when direct current is applied to the stator has been an elusive development. The question is not one of widespread importance but, in some control applications, a sure knowledge of the speed-torque relationship might be critically important.

The torque is found to be produced mainly by the a-c power of variable frequency which is developed in the rotor as it slows to a stop. This part of the braking effort may be calculated with precision by considering the machine as a short-circuited alternator with revolving armature. The saturation curve and the direct axis synchronous impedance line at rated frequency are needed to establish the synchronous impedance. Saturation is taken into account directly by calculating the synchronous impedance for the particular value of direct current being used. The synchronous impedance line is located by one point which is determined from locked rotor input. The current flowing into the stator of the machine under blocked rotor conditions is the vector sum of the current needed to magnetize the leakage flux paths, to overcome the demagnetizing effect of the magnetomotive force of the rotor current and to provide the small amount of exciting current required to develop the air gap flux. The magnetizing current is a small portion of the total and depends on the relative sizes of the magnetizing impedance and the rotor impedance which are in parallel in the equivalent circuit. Assuming a 1:1 turn ratio, the synchronous impedance line thus is seen to be close to a 45-degree line, if equal current scales are used in the plot.

The frequency of the induced rotor currents is proportional to speed and the synchronous reactance is proportional to frequency. The magnitude of the induced rotor voltage is also proportional to speed. An expression can be developed therefore to relate braking torque to speed based on these fundamental frequency quantities:

$$T=\frac{21.1C^2NR_2}{R_2^2+(KN)^2} \qquad (1)$$

where C is the induced voltage per synchronous revolution per minute at rated frequency and at the d-c excitation level chosen; this is taken from the saturation curve. K is synchronous reactance referred to the primary in ohms per phase, per synchronous revolutions per minute at rated frequency. R_2 is secondary resistance in ohms per phase referred to the primary. N is speed in revolutions per minute, and T is braking torque in pound feet.

The slot harmonics in the air gap flux wave induce higher frequency voltages in the rotor conductors which are not included in this analysis. The effect of these currents is to raise the apparent resistance of the rotor above the d-c resistance level. The apparent resistance of the rotor varies from the d-c value at zero speed to a value perhaps 70 per cent higher at about 10-per-cent synchronous speed. At speeds above this level the resistance is very nearly constant. This tapering of rotor resistance at low speeds raises the torque calculated by the foregoing formula and affects the speed at which maximum torque occurs.

At low speeds, another harmonic effect is present in the form of inductor generator torque. The flux in the rotor teeth pulsates as a result of the nonuniform nature of the surface of the stator bore. The frequency of the flux pulsations is a direct function of speed and number of stator teeth so that at low speeds the inductor alternator currents in the rotor coil linking a tooth become relatively large and produce from 10 to 50 per cent as much torque as the synchronous currents and the slot harmonic currents combined. This effect occurs in the region of maximum torque and is proportional to the square of the d-c excitation current, assuming unsaturated iron. The effect of inductor alternator torque, while large in magnitude, does not have a profound effect on average torque.

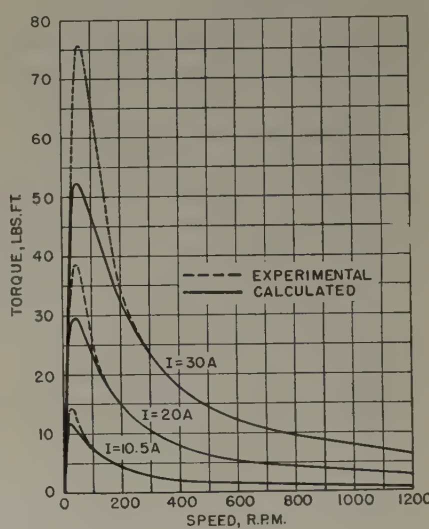

Figure 1. Torque speed curve calculated and by test

The average torque calculated by this method is always in error on the low side, at high excitation currents as much as 8 per cent low.

Figure 1 shows the comparison of experimental and calculated torque speed curves for a 5-horsepower 220-volt class *A* motor.

Digest of paper **53-304**, "D-C Dynamic Braking of Squirrel-Cage Induction Motors," recommended by the AIEE Committee on Rotating Machinery and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Summer General Meeting, Atlantic City, N. J., June 15–19, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

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A Subscriber Toll Dialing Tape Reader

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IN ONE SYSTEM of customer toll dialing,[1] the call record is a punched tape as shown in Figure 1. A simple recorder containing punch and step magnets driven directly by dial impulses produces the tape record. Transcribing information from the tape by eye would be slow and cumbersome; hence an automatic "reader" is needed to translate the information to a more convenient form.

The availability of an inexpensive printer[2] led to the development of a reader that prints tickets of the type illustrated in Figure 2. The punched tape, received from the recorders on reels, is driven past a phototube scanning device which controls relay circuits that count the holes and actuate the printer. The circuits include automatic means for rate selection and charge computation.

To place an interexchange call, the telephone user dials an office code (usually two digits) for the town he wishes to reach, then dials his own telephone number, and then dials the desired telephone in the distant office. The first digit of the office code selects a tape recorder; the second digit completes the office selection and is punched in the tape to record the identity of that office. Following that, the two telephone numbers are punched as dialed.

When the call is answered, a "calendar" punches the calling office code, a day-night digit, and the date and time of day. Then a clock punches the tape once a minute to record the duration of conversation. The tape recorder circuit automatically produces spaces between series of holes to separate digits, numbers, and complete calls.

In the tape reader, the tape rides over a mask containing four slots of different lengths, each slot associated with a phototube. One slot is used for counting holes, the other three recognize the three different widths of spaces between holes.

The tape is scanned backwards in order to avoid re-reeling and to permit recognition of incomplete calls. If a call is unanswered, no calendar or clock information is punched; then the first thing scanned is the last digit of the called telephone number instead of the minutes talked. Because the widths of succeeding spaces are different in the two cases, the reader recognizes the incomplete call immediately and does not print a ticket.

Reader operation consists essentially of counting each

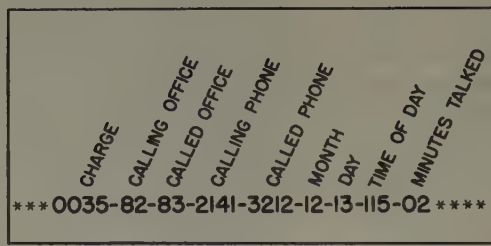

Figure 2. Printed ticket

series of tape holes and energizing the corresponding digital lead to the printer. A clutch stops the tape after each digit scanned, restarts it after printing. Information is printed as it is scanned except for the day-night and calling office digits, which are stored without printing. The minutes talked and called office digit also are stored besides being printed. After the called office digit is received, an "8" or other appropriate digit is automatically prefixed to create the full 2-digit code assigned each office. Then the calling office code, which was stored earlier, is printed, followed by the charge.

The two office codes determine the basic rate, and the day-night digit informs the reader whether weekday or night-Sunday-holiday rates apply. The rate is combined with the minutes talked to produce the charge. Rate selection and computation are performed by rather simple relay circuits which include "self-checking" features to preclude mistakes. Rates can be changed by means of strapped connections on a terminal block.

The tape scanning speed is 50 holes per second, producing about 350 printed tickets per hour. Tickets are the same size as standard operator-written toll tickets to facilitate handling and sorting.

Intended for small independent telephone companies, the reader was designed with the objectives of reliability, simplicity, and low cost. The model described contains about 10 electron tubes and 100 telephone-type relays. A smaller model, containing half as many relays, is also made for 2-office networks where automatic rate selection is not required. The physical size of the machine permits table or desk top use.

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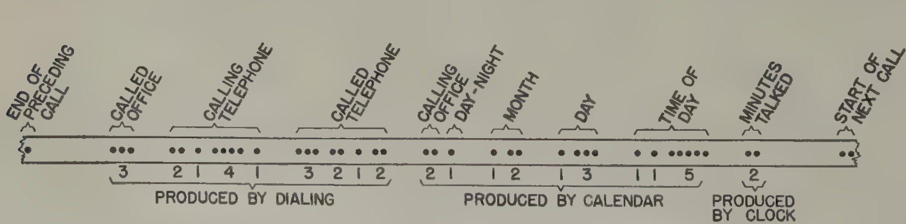

Figure 1. Punched tape. Called office and day-night entries are sometimes omitted

A Level Compensator for Telephotograph Systems

T. A. JONES W. A. PHELPS

To eliminate interference in telephotograph transmission through broad-band carrier equipment, it was decided to cancel it from the signal delivered by the carrier facility instead of modifying the carrier equipment. Consequently, a recently developed telephotograph level compensator, consisting of a pilot channel arrangement designed for insertion in the telephotograph connecting circuits, is utilized.

SINCE 1936, a number of different telephotograph systems[1] have been operated over the lines of the Bell System on a leased-wire basis. The requirements which a line facility must meet for such service are in several respects more severe than the requirements for voice-message service. Telephotograph transmission requirements usually have specified that abrupt variations in line net loss should be limited to ±0.2 decibel, single-frequency noise power should be at least 50 decibels below maximum signal power, and throughout the useful frequency band (1,200 to 2,600 cycles) the envelope delay should be equalized within ±300 microseconds. Such requirements were originally satisfied by using 4-wire *H-44-25* side circuits in cable where available and elsewhere by using 2-wire open-wire side circuits. These facilities were delay equalized over the necessary frequency range, and precautions were taken to minimize various transmission disturbances.

However, the long voice-frequency loaded cable circuits such as those which formerly connected New York and Chicago have been largely supplanted by multichannel (so-called "broad-band") type *K* carrier telephone systems[2,3] operating on nonloaded cable pairs, or by type *L* carrier telephone systems[4] working over coaxial cables. Special services such as carrier telegraph, program, and telephotograph transmission now must use channels of these broad-band carrier systems for long-haul applications, and this requirement has brought new problems. For speech transmission the complex pilot regulating equipment of the broad-band systems accomplishes substantially perfect control of the line net loss, but it produces frequent variations of a few tenths of a decibel, which are often sufficient to cause marked deterioration in the quality of transmitted pictures. Also, signals passing through type *K2* carrier systems are slightly affected by 60- and 120-cycle modulation caused by the a-c filament supply used for some of the amplifier tubes. This effect, also, is negligible for speech transmission, but is sometimes quite apparent in transmitted pictures.

The possible severity of these types of interference is shown in Figure 1, which is a section of a picture transmitted over a New York–Chicago–Atlanta–New York loop composed of a number of type *K* carrier channels in tandem. For comparison, the same picture before transmission is shown in Figure 2. In the transmitted picture of Figure 1, which is built up of vertical lines, it may be noted that in some areas which should have a constant shade almost every line has a different density, and on each side of the picture there is a group of very dark lines caused by larger level changes. The whole picture is covered by slanting striations due to power-frequency interference. It should be realized, however, that these defects are normally less pronounced than in Figure 1, which was chosen to illustrate the problem clearly.

Instead of modifying the carrier equipment to eliminate the interference at its several sources, it was deemed more practical to cancel the interference from the signal delivered by the carrier facility. This function is performed by the recently developed telephotograph level compensator, which consists of a pilot channel arrangement designed for insertion in the telephotograph connecting circuits. This arrangement utilizes a single-frequency pilot current

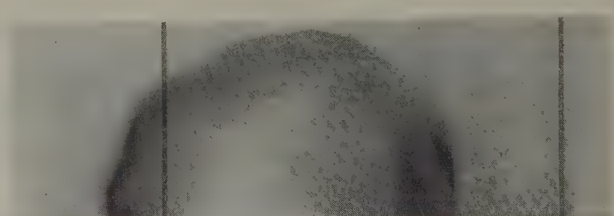

Figure 1. Variations in shade produced by pilot regulator action and power frequency interference on a multisection type K carrier circuit

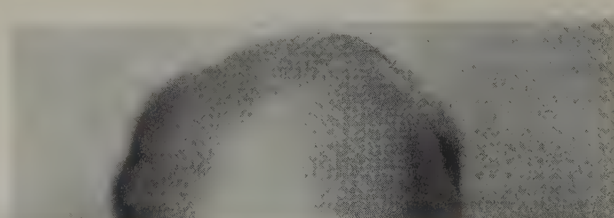

Figure 2. Original print

Full text of paper **53-297**, "A Level Compensator for Telephotograph Systems," recommended by the AIEE Committee on Telegraph Systems and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Summer General Meeting, Atlantic City, N. J., June 15–19, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

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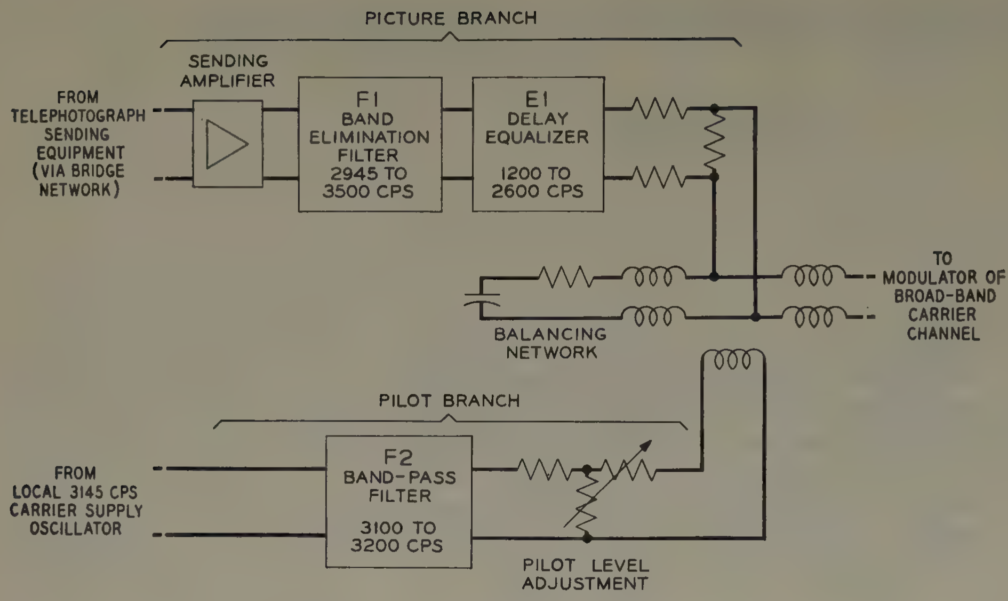

Figure 3. Level compensator sending circuit

which is transmitted over the line facility along with the picture current, and is modulated during transmission by the same interference which modulates the picture signal. After transmission the modulated pilot current is separated from the picture current and is rectified in order to recover the low-frequency interference. The interference is then used to remodulate the picture current in phase opposition to the existing modulation. The use of the level compensator results in a substantial reduction of interfering low-frequency amplitude modulation resulting from level changes or power-frequency interference.

DESCRIPTION OF THE LEVEL COMPENSATOR TERMINAL CIRCUITS

The level compensator sending circuit is shown in Figure 3. In this circuit a 3,145-cycle pilot current, obtained from the standard carrier supply equipment used in carrier telegraph systems, is combined with the 1,200- to 2,600-cycle picture signal from the sending subscriber. From this circuit the picture and pilot currents pass to the carrier-telephone sending equipment. The pilot frequency has been chosen above rather han below the picture signal band so that the full frequency range of the carrier telephone channel below 2,700 cycles is available to the subscribers for alternate speech transmission when desired. Filter *F1* provides substantial attenuation to picture or speech frequency components lying in the pilot channel band between 2,945 cycles and the 3,500-cycle upper limit of the carrier telephone channel. Such components thereby are prevented from actuating the receiving compensator equipment. Equalizer *E1* equalizes the delay of this filter over the picture signal frequency band. Filter *F2* attenuates certain extraneous frequency components which are present in the 3,145-cycle carrier supply. The level of the pilot current delivered by the sending circuit is adjusted 13 decibels below that of the maximum picture current. This adjustment permits the pilot current to be transmitted well above line noise without causing appreciable intermodulation with the picture current.

The level compensator receiving circuit, shown in Figure 4, is connected between the output terminals of the broad-band carrier-telephone channel and the receiving subscriber. In this circuit the picture and pilot currents, together with any modulated interference picked up during transmission, are separated by low- and high-pass filters. The picture current from low-pass filter *F3* flows through delay equalizer *E3* which corrects the delay distortion of the filter, into a variolosser network consisting of a special type of balanced modulator. This network contains fixed resistors as series elements and a varistor bridge as a shunt element. The picture current flows through the variolosser at levels low enough to result in negligible signal distortion. The pilot current, after passing through high-pass filter *F4* and its delay equalizer *E4*, is amplified, rectified, and passed through low-pass filter *F5* in order to recover any low-frequency modulation to which the pilot current may have been subjected during transmission. This low-frequency

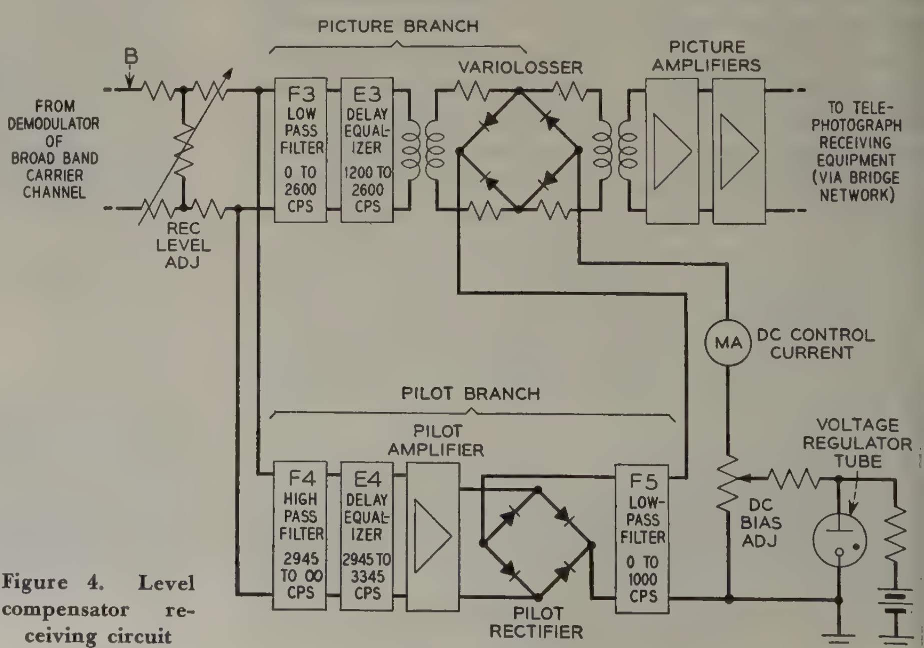

Figure 4. Level compensator receiving circuit

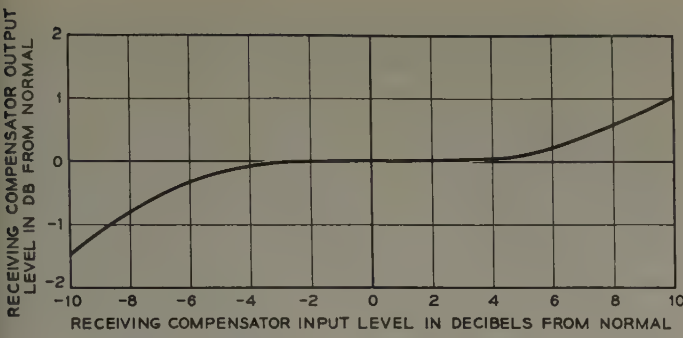

Figure 5. Variation in output level with input level of level compensator receiving circuit

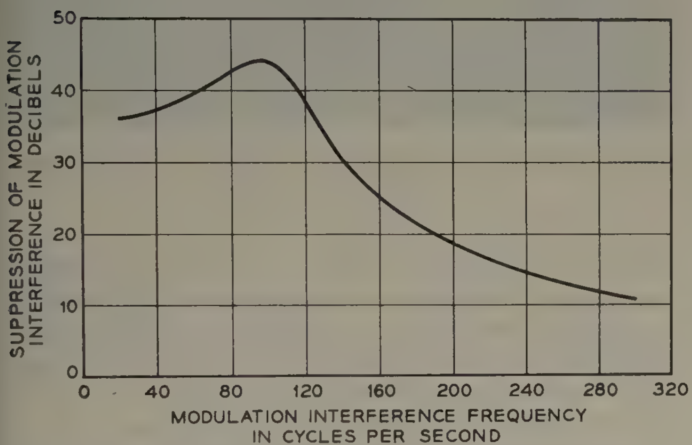

Figure 6. Suppression of line modulation interference by level compensator as a function of modulation frequency

current, in series with an adjustable d-c bias current, is used to control the resistance of the varistor bridge network in the variolosser and thus to control the transmission loss introduced by the variolosser in the picture branch.

For effective operation of the level compensator the transmission loss of the variolosser, as controlled by the modulation envelope superimposed on the pilot current, must vary in magnitude and phase so as to cancel the interference envelope superimposed on the picture current. The magnitude requirement is met by proper adjustment of the pilot amplifier gain and d-c bias current. The phase requirement is met by designing the picture and pilot branches so that modulation frequencies up to about 200 cycles suffer substantially the same delay in the two branches.

DELAY EQUALIZATION OF THE CARRIER TELEPHONE CHANNEL

As previously mentioned, for satisfactory operation of the types of telephotograph system under consideration the maximum deviation of the envelope delay of the transmission circuit from end to end should not much exceed ± 300 microseconds over the picture signal-frequency band from 1,200 to 2,600 cycles. When the picture signals are transmitted over a broad-band carrier facility, the principal sources of delay distortion are the channel band-pass filters of the carrier telephone terminals. This distortion must be corrected by delay equalizers to meet the requirement just stated.

When a level compensator is added to a carrier-telephone channel in order to reduce the effect of amplitude-modulation interference at frequencies up to 200 cycles, the problem of equalizing envelope delay of the carrier facility becomes somewhat greater. Such interference may be introduced by the terminal amplifiers or line repeaters of the carrier facility. At the points of introduction, simultaneous modulation of the picture and pilot carriers occurs. In order that the pilot carrier modulation may be used effectively to cancel the picture carrier modulation in the level compensator receiving circuit, both must reach the variolosser in this circuit simultaneously. To accomplish this, the envelope delay effective over a frequency band extending 200 cycles above and below the pilot frequency must be adjusted to the same value as that effective over a band 200 cycles above and below the picture carrier frequency. For this reason the delay equalization of each carrier channel filter carrying the picture and pilot currents must be effective over the pilot band as well as the picture band; that is, from 1,200 to 3,345 cycles. In a multisection carrier facility consisting of channels of two or more carrier-telephone systems connected in tandem the channel filters at each connecting point must be delay equalized at that point, so that interference introduced in any or all sections can be compensated at the receiving terminal.

The delay equalizers provided for the carrier-telephone channel filters and for the receiving level compensator circuit are sufficiently accurate so that the level compensator may be expected to reduce level changes and 60- and 120-cycle modulation interference by at least 20 decibels if the number of carrier sections in the line facility is not too great. This degree of interference reduction has been found adequate to render broad-band carrier facilities suitable for telephotograph transmission.

PERFORMANCE CHARACTERISTICS

A typical characteristic showing the variation of the output level with the input level of a properly adjusted level compensator receiving circuit is shown in Figure 5. This curve indicates that, in the absence of power frequency modulation, level changes in the line

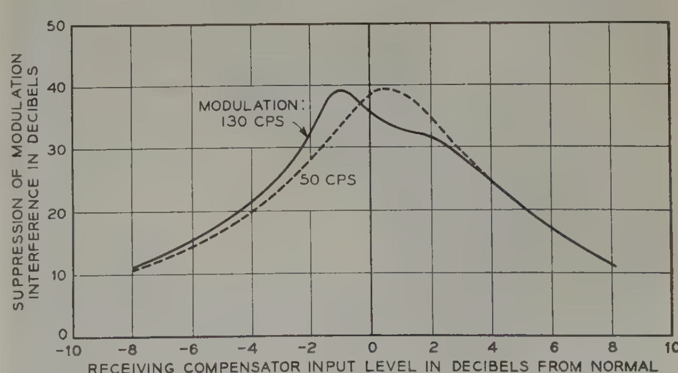

Figure 7. Suppression of line modulation interference by level compensator as a function of level at input of receiving compensator circuit

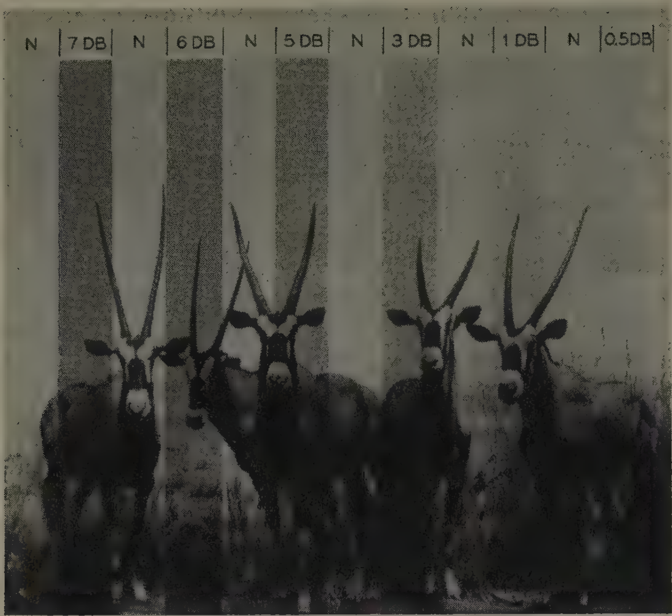

Figure 8. Effect of level changes made in local test without level compensator*

Figure 9. Effect of level changes made in local test with level compensator in circuit*

facility as large as ±5 decibels can be tolerated without exceeding the usual limit of ±0.2 decibels in the receiving subscriber's loop. The adjustments necessary to obtain this performance are made easily with the aid of simple testing equipment, and when made are stable over a period of several weeks.

After the circuit has been adjusted for level compensation, its typical performance with respect to modulation interference over the frequency range from 0 to 300 cycles is shown in Figure 6. This curve applies to the level compensator sending and receiving circuits connected together by an artificial resistance line containing a source of modulation interference. The reduction of such interference due to the use of the compensator is plotted as a function of the modulation frequency, and amounts to nearly 40 decibels for 60- and 120-cycle interference. Of course, the interference compensation obtained during transmission over an actual carrier facility would be considerably lower due to imperfections in the delay equalization of the facility.

The performance of the level compensator equipment when simultaneous level changes and 50- or 130-cycle modulation are introduced in the connecting resistance line is given by the curves of Figure 7. These curves show that the protection against modulation in the power-frequency range falls off as the line loss departs from its normal value. However, it is expected that a substantial compensation for

* Original photograph made in the American Museum of Natural History by courtesy of the museum.

Figure 10. Effect of 120-cycle modulation interference in local test without level compensator

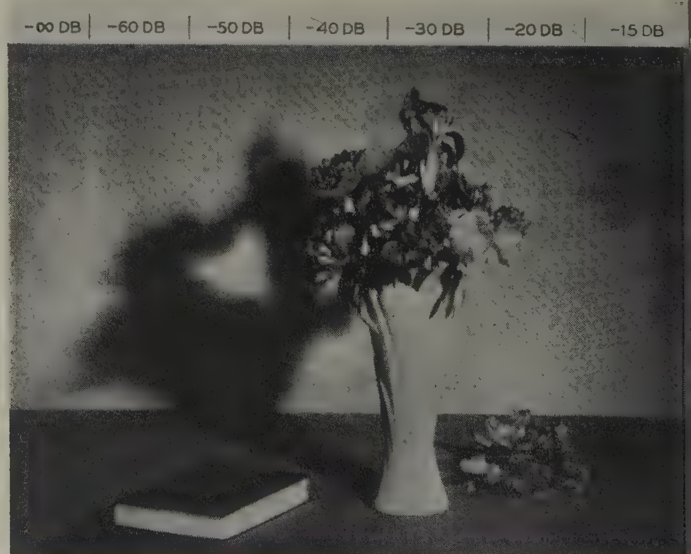

Figure 11. Effect of 120-cycle modulation interference in local test with level compensator

such interference will be obtained in actual practice since the variations in line net loss normally encountered in broad-band carrier channels are small.

A sample picture, locally transmitted, containing line level changes from 0.5 decibel to 7 decibels with no level compensator in the circuit, is shown in Figure 8. The effect of a level change of 0.5 decibel may be seen clearly in the picture. The same test picture transmitted with the level compensator in circuit is shown in Figure 9. Here no change smaller than 6 decibels produces a noticeable effect.

Sample pictures were also locally transmitted to illustrate the performance of the level compensator in reducing the effect of 120-cycle modulation interference on the line. The picture of Figure 10 was transmitted without the level compensator and that of Figure 11 was transmitted after the compensator had been added. No interference pattern is visible in Figure 11, even for modulation levels only 15 decibels below the maximum picture level.

The tests which so far have been made over actual broad-band carrier facilities indicate that the level compensator should greatly extend their usefulness for telephotograph transmission.

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Magnetic Amplifier Circuits and Applications

R. A. RAMEY

The most commonly used magnetic amplifier circuits and their applications are reviewed in their general form. The information is presented in the order of invention or use and thus follows quite closely the chronological sequence.

AN INTRODUCTION to the general operation of magnetic amplifiers and the methods of analysis developed for this technology has been provided in the two previous articles. The types of components ordinarily used in these circuits and relations which govern the gain, response, linearity, and so forth were discussed also. In this article the various magnetic amplifier circuits which are used most generally will be reviewed in their general forms.

In reviewing magnetic amplifier circuits, it would be quite hopeless to include all the magnetic amplifier circuits which have been proposed and used. Actually, there have been some 500 patents granted in this subject, each one disclosing a different feature or configuration. To name and describe all of these circuits would be impractical of course. The skilled designer will have knowledge of the basic types of circuits; however, his knowledge of specialized circuits will be limited ordinarily to the field in which he is most interested.

This complexity of circuitry and specialization is not expected by one unfamiliar with the magnetics field. The field is considered to be relatively new, and one is apt to refer to a magnetic amplifier as a general category, thinking perhaps that there are only a few magnetic amplifier circuits. It is hoped that the preceding statements have dispelled this notion.

CIRCUITRY

THE FIRST TYPES OF circuits one finds in the literature are the simple reactor or transductor circuits and their series and parallel combinations, see Figures 1 and 2. Winding polarities are indicated by dots. E_c and e_{ac} are the control and power voltages, R_c and R_L the control and load impedances, and I_c and I_L the input and output currents, respectively.

These circuits were introduced around the beginning of the second decade of the century and since have found considerable application where speeds of response are not of importance, mainly in metering and relatively slow control applications such as theater light dimming. This type of circuit is characterized by low gain, slow response, and considerable linearity. The possibilities of application of these basic circuits in modern control technology are limited, mainly by the slow speed of response. A major advantage for this amplifier, particularly in metering, is its rather definite one-to-one ratio of control ampere turns to load ampere turns independent of load throughout wide ranges, see Figure 3. An example of the saturable transformer amplifier is shown in Figure 4. Its per-

Condensed text of a conference paper presented at the AIEE Winter General Meeting, New York, N. Y., January 19–23, 1953, and recommended for publication by the AIEE Committee on Magnetic Amplifiers. This is the last of a series of three articles on the fundamentals of magnetic amplifiers. Part I, "The Magnetic Amplifier," by W. C. Johnson, appeared in July 1953, pages 583–8; Part II, "Methods of Magnetic Amplifier Analysis," by L. A. Finzi and G. F. Pittman, Jr., appeared in August 1953, pages 690–4.

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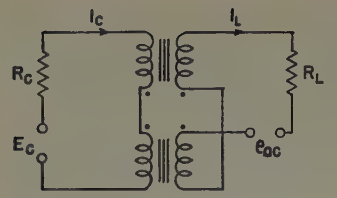


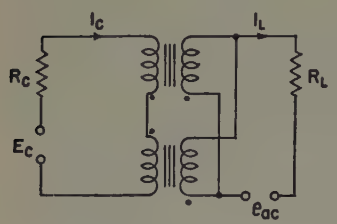
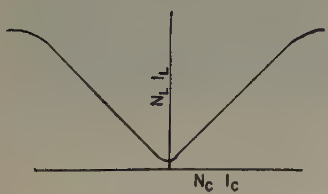


Figure 1 (top). Series transductor. Figure 2 (bottom). Parallel transductor



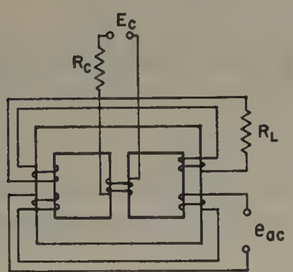


Figure 3 (top). Transductor transfer characteristics. Figure 4 (bottom). Saturable transformer

formance falls in the same category, but it has the advantage of isolating load from power source.

With the advent of the dry-type rectifier in the second decade, feedback circuits were introduced to the basic circuits. These are the so-called external feedback configurations exemplified in Figure 5. These circuits usually require a bias winding, but that fact will be ignored here.

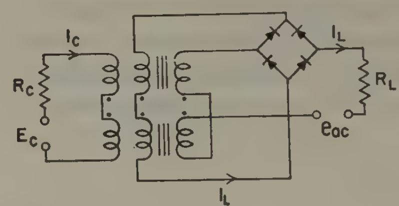
This additional circuitry increases the gain obtainable from magnetic circuits tremendously. With these amplifiers it is possible to realize gains of 1,000,000 in a stage. Furthermore, the ratio between gain and speed of response is considerably altered by these configurations such that if one chooses to take nominal gains, perhaps 300 to 1,000, the speed of response obtainable is very short indeed, possibly in the order of two or three cycles of line frequency. These circuits have figures of merit (ratio of power gain to speed-of-response in cycles of power frequency) of the order of 500, whereas the simple basic circuits had figures of merit in the order of four. With this type of configuration it now is possible to begin considering seriously magnetic amplifiers in many modern problems. With the introduction of feedback one finds an additional component type in the circuits, the rectifier. One finds further that linear relations in the basic circuits are no longer easily obtainable. The transfer characteristic is appreciably altered and can be made to vary in position from that of the simple transductors, see Figure 3, to that exemplified in Figure 6 by the addition of more and more feedback ampere turns. After the feedback exceeds 100 per cent, triggering occurs and one has a bistable element, see Figure 7, useful in switching applications.

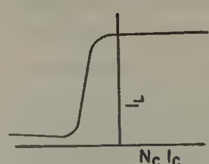
Whereas in the basic circuits the specific magnetic characteristic of the material did not alter the transfer characteristic appreciably, here the transfer characteristic is determined with certain uniqueness by the specific material quality. It is with these circuits that it is necessary to have rectangular loop materials with extremely low losses and the best rectifiers to attain highest performance.

With external feedback, it is necessary to drive the output circuit currents through a second winding on each reactor core introducing an added resistance drop. This deleterious effect was obviated by the introduction of the self-saturating magnetic amplifier circuits in the third decade, see Figures 8 and 9.

These circuits correspond to 100-per-cent feedback with the external feedback connections, and again the transfer characteristic depends directly on the quality of magnetic material and rectifier used and the transfer characteristic is that of Figure 6. With the self-saturating circuit the figure of merit obtainable with the best present-day materials and design techniques runs as high as 3,000 to 5,000. The external feedback scheme can be combined with self-saturation to increase gains further, see Figure 10. The amount of additional feedback which may be used before triggering occurs, see Figure 7, is usually slight.

All the circuits considered to this point are of the single-





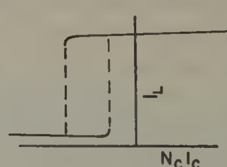
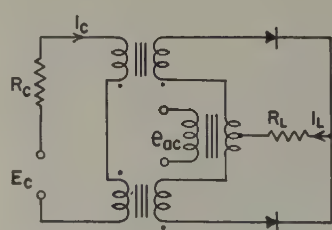


Figure 5 (top). Series amplifier with external feedback. Figure 6 (bottom left). Transfer characteristic with external feedback approaching 100 per cent. Figure 7 (bottom right). Transfer characteristic with external feedback over 100 per cent



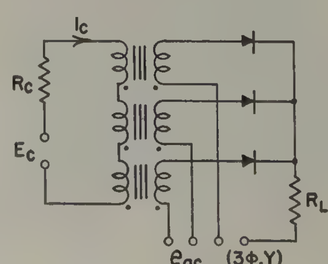
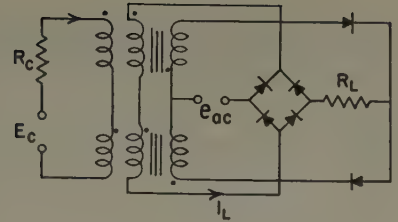


Figure 8 (top). Self-saturating "full-wave" magnetic amplifier. Figure 9 (bottom). Self-saturating 3-phase magnetic amplifier



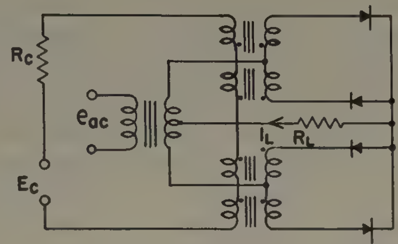
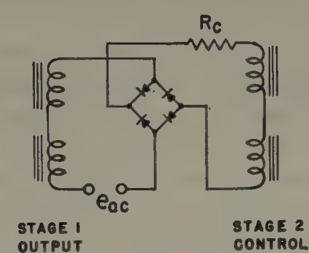


Figure 10 (top). Self-saturating "doubler" magnetic amplifier with external feedback. Figure 11 (bottom). Push-pull self-saturating magnetic amplifier



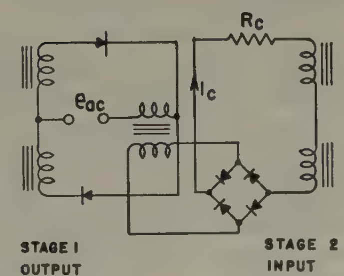


Figure 12 (top). Direct interstage coupling. Figure 13 (bottom). Transformer interstage coupling

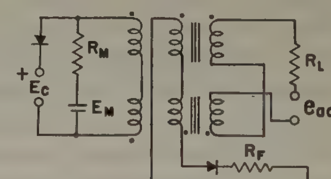
ended variety; however, many applications require a reversing output. This type of output can be obtained quite readily by operating the single amplifiers in push-pull as shown in Figure 11. There is considerable loss in efficiency in reversing a d-c output because one side short-circuits the other.

In cases where very large power gains are required from input signal to output level but very rapid response is necessary, it is essential to cascade magnetic amplifier stages. Should one attempt to attain 1,000,000 gain in one stage, he would have to allow a considerable amount of time for the amplifier to respond; however, if he chose instead a gain of 1,000 of a suitable design, he would have a response of one or two cycles. When amplifiers are cascaded, the gains essentially multiply and the times of response essentially add; so to obtain a gain of 1,000,000, it is only necessary to cascade appropriately two stages with gains in excess of 1,000 each. There are several coupling means useful for cascading. They are exemplified by those shown in Figures 12 and 13.

The circuits heretofore mentioned are all examples of the types developed before World War II. At this time very little application was made with magnetic amplifiers and the general activity of invention should have been reasonably low. This certainly was not the case; for the circuits in most use today were invented in this period. It seems that it was somewhat more than difficult to introduce this new technology to the American engineering storehouse, and it took the activities of our erstwhile enemies, the Germans, to sell the United States on the idea of the use of magnetic amplifiers. When it was learned that the reliability and maintenance-free operation predicted for these circuits were being obtained in the German war machine, considerable activity was instigated in the United States to develop these circuits for application here. First, new and improved magnetic materials and rectifiers were developed for the existing circuits, and research and development was carried on to determine the most advantageous circuit configurations for various applications.

Many particular circuits have been developed in the last decade. The new types are mostly high-speed circuits with particular emphasis being put upon rapid response times. Figures 14, 15, 16, and 17 show examples of these high-speed circuits. The circuits of Figures 15, 16, and 17 require only a half-cycle of power frequency for 100-per-cent response.

The field of magnetic amplifiers or magnetics, as it is known, encompasses the study of more magnetic devices than those which are considered straight amplifiers. Various computing circuits, modulators, references, and lead networks have been developed using magnetic non-linearities and rectifiers. In Figure 18 is shown an example of a magnetic flip-flop, having an operating time of one-half cycle of supply frequency. In Figure 19 is shown one



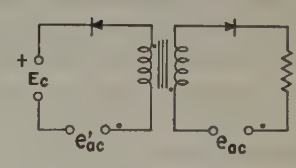
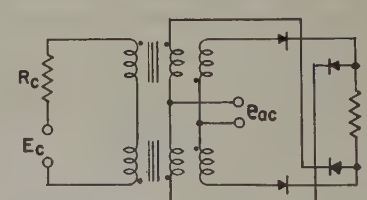


Figure 14 (top). Series amplifier with internal feedback. Figure 15 (bottom). Single-core magnetic amplifier



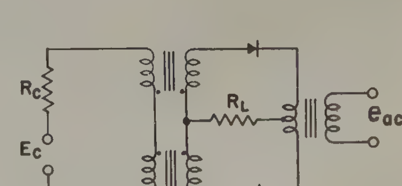
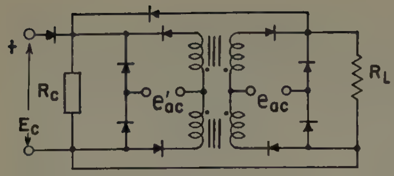


Figure 16 (top). Half-wave magnetic amplifier bridge circuit. Figure 17 (bottom). Push-pull full-wave magnetic amplifier



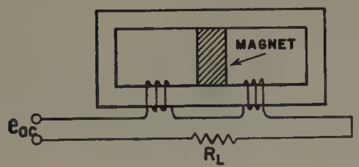


Figure 18 (top). Magnetic flip-flop. Figure 19 (bottom). Permanent magnet reference

type of magnetic reference device whose output is substantially constant. This circuit provides a reference or standard voltage and current for regulating systems. Here the constant field of a permanent magnet provides a constant control magnetomotive force and consequently a constant output. There are more advanced reference devices upon which no publication has yet been made. Figure 20 is a type of magnetic lead network which, in quite small spaces, serves the function of conventional lead networks with several thousand microfarad capacitors; it is also quite nondissipative.

APPLICATIONS

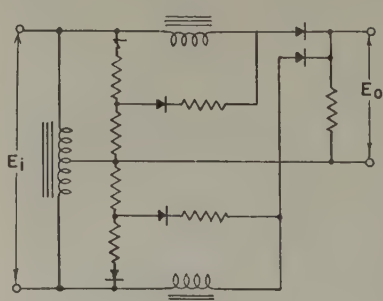
The range of application of magnetic amplifiers is wide and varied, being limited usually by the speed of response of the amplifier and by the particular waveform characteristic obtainable from it. Since the instantaneous value of the output does not reproduce the instantaneous input value, it is necessary not only to measure the output versus input characteristic of the amplifier as average values, but also to make applications which can make use of this same type of operation. The types of uses which can be made of these circuits recognizing these inherent limitations are many and varied, depending ultimately upon the maximum frequency for which one can obtain materials for these amplifiers. They are being used in servo amplifiers; temperature-measuring devices; regulators of speed, voltage, and frequency; d-c amplifiers and modulators; frequency reducers and multipliers; audio- and radio-frequency amplifiers; trigger and multivibrator circuits; and delay lines and memory devices, and so forth.

Looking at such a listing of applications, one gets the impression that magnetic amplifiers are sensitive, high-gain, high-speed, versatile devices capable of delivering large quantities of power efficiently. Each of the adjectives is applicable, but it is seldom practical to combine within one amplifier all the attributes mentioned. For instance, it is not practical to control a large generator field with amplifiers whose excitation frequency is of the order of a megacycle even though the amplifiers' speeds of response would be phenomenal. Fortuitously, most applications requiring large blocks of power from amplifiers do not have the concomitant requirement that the amplifier show such speed. Ordinarily 1/100 of a second delay, four cycles at 400 cycles per second, in the amplifier will pass unnoticed. In most measurement applications, the speed of response is really of negligible interest—as the meters are slow.

In applications where physical displacements or speeds of mechanical apparatus are being controlled, one finds the magnetic amplifier enjoying considerable application today. Usually such systems are motivated by electric motors which have definite limitations as to their speed of response determined by the torque inertia ratio which can be designed into them. This delay easily can be shown experimentally by switching a reverse voltage on a motor—the motor does not respond instantaneously but takes definite time to attain reverse speed. A little delay in the switching (amplifier) would not appreciably alter the response, so magnetic amplifiers can be designed to give essentially the same performance as electronic amplifiers. The ordinary motor does not usually have fast response characteristics and presents no particular problems to designers, for it is not considered in high-performance systems. However, servo motors are particularly designed for rapid response and usually present a challenge, particularly when very-high-power gains with their concomitant delays are required of the amplifiers.

The same general remarks applicable to inertial loads are true of inductive loads such as generator fields. The time constant of a field is usually the important delay. Fast response of generator fields requires "field forcing" with resistive networks or lead networks to lower the time constant effectively whether one uses magnetic amplifiers or any other control means.

In application of magnetic amplifiers to particular problems, it is necessary to consider three factors: first, the signal source; second, the gain and time constant required; and third, the load into which the amplifier must work. There are very definite limits placed upon the signal sources which might be used. The most general requirement with present-day materials and circuits is that the signal level be above 10^{-9} watt. Below this level amplifier drifts and other types of instability render applications ineffective. The major problem at low level is that of rectifiers. Rectifiers have definite forward voltage drops and in themselves are not low-level loads. It is necessary to design even the low-level amplifiers with



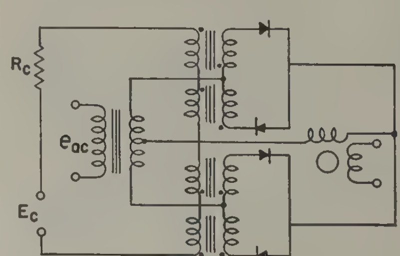


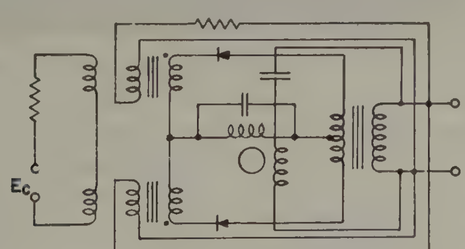
Figure 20 (top). Lead network, full-wave d-c output. Figure 21 (bottom). Push-pull doubler control of 2-phase motor

relatively high alternating voltages for supply because of these rectifiers. This makes winding of very small structures quite difficult since many turns are needed even at higher frequencies. In addition, rectifier capacitance begins having a considerable effect at very low voltage levels. With power inputs of the order of 10^{-8} watt, one usually experiences no difficulties.

It is usually in these low-level first stages that one experiences his greatest time delays. The usual effort of the designer is to get himself up out of the very-low-level power region with as few stages as possible. This means that the very first stages must have large gains with their associated long-time delays. In the higher level stages, the delays are quite short because lower gains are accepted readily. In general, this is a problem in miniaturization and the development of more ideal rectifiers. Were it possible to design effective amplifiers with gains of the order of 1,000 and output level of the order of 1 microwatt, such problems would not be so difficult. Effective design requires that each stage have relatively short time constant, and when low levels must be used for signals, it is necessary to cascade several stages of amplifiers to attain appropriate gain–time constant relations.

The various loads which magnetic amplifiers are expected to work into can be classified as resistive, inductive, capacitive, and active loads, or combinations of these. In the practical sense, they may be lamps, motor generator fields, and power supply filters. A few examples of a-c motor control circuits are shown in Figures 21 and 22. The d-c control of generator fields or other inductive loads can be accomplished by the circuit shown in Figure 23. An example of d-c power supply is shown in Figure 24.

In the audio-amplifier field, the magnetic amplifier is required to reproduce the input signal waveform. This is not the nature of the magnetic amplifier at all. The amplifier being a modulation device cannot reproduce information at a rate in excess of a-c power supply frequency. When a magnetic audio amplifier is designed, a-c power must be provided to this device some several times the frequency of the highest audio component expected to be reproduced. The applications in this region are limited



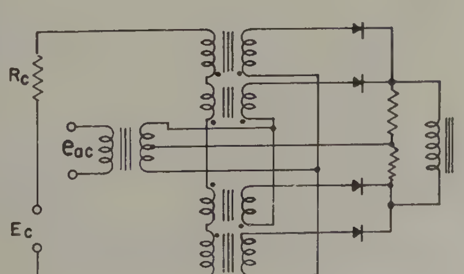
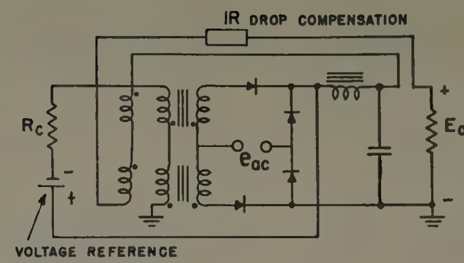


Figure 22 (top). "Full - wave" damped control of 2-phase motor. Figure 23 (bottom). Balanced magnetic amplifier for inductive loads



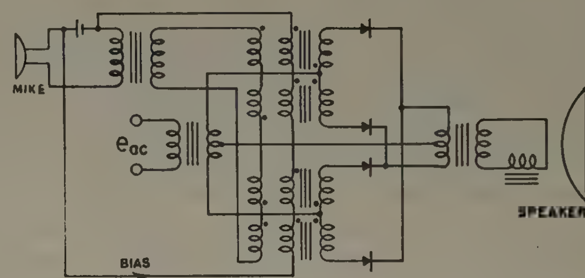


Figure 24 (top). Elementary d-c power supply. Figure 25 (bottom). Magnetic audio amplifier

mainly because it is usually necessary to supply this a-c power from an electronic oscillator. A further difficulty is that the rectifiers heat up far more than usual when the power supply reaches several kilocycles. An example of a magnetic audio amplifier is shown in Figure 25. Here care must be exercised to match the amplifier internal impedance to the load.

In computer applications one is not limited ordinarily by the loading device. If it is necessary in high-speed applications, the results of a problem can be stored on a tape and read out onto electric typewriters. This information processing can be carried on at any required level, and the requirement that the input be exactly the same function as the output is not necessarily met. Ordinarily, one is not here limited by the low-level problem.

The application of magnetic amplifiers is only beginning. Since the illustrations shown here are from the published literature and do not include the most recent advances in the art, they are somewhat outdated and applicable to lower performance. Work and publications now in process will include startling new applications and show the invasion of magnetics further and further into the regions heretofore reserved for electronics (notably, the information-processing field). New materials, processes, and circuits are being developed and applied to promote this invasion.

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Transfer Function Measuring and Recording System

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THE SYSTEM DESCRIBED gives a polar plot of the transfer functions of industrial processes, process controllers, and instrument servomechanisms. Included in the system is an accurate mechanical signal generator which produces pneumatic, electric, and motion sine waves having a frequency range of 1/30 to 720 cycles per minute. A data sampling technique is employed which by-passes the need for having recorders with a dynamic response considerably better than the system under test. Furthermore, the Nyquist plot is recorded directly on a single sheet of paper thus simplifying the data reduction,

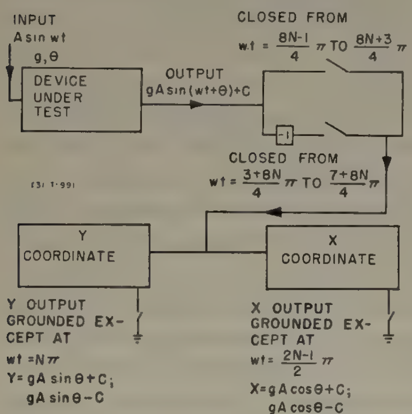

Figure 1. Block diagram showing principle of operation

handling, and storage problem. As the transfer function may be studied while the test is in progress, the operator is assured that he will not miss any significant points of the plot.

Figure 1 illustrates the general method of obtaining the transfer function. A sinusoidal test signal, $A \sin \omega t$, is applied to the device under test which has a transfer function $g\epsilon^{j\theta}$, where g is the amplitude ratio and θ the phase shift. The output from the device then will be: $gA \sin(\omega t + \theta) + C$ which can be represented by a vector having a magnitude gA, making an angle θ with the input vector, plus a constant term C. By suitable resolving means, the X and Y components of the output vector are measured and used to position the two co-ordinates of a function plotter which traces the vector locus. This method of resolving the X and Y components is accomplished by sampling the output sine wave at 90-degree intervals.

The sampling is performed by means of switches synchronously driven from the signal generator shaft which sample the output signal at 0 and 180 degrees of the input wave for the Y co-ordinate and at 90 and 270 degrees for the X co-ordinate. Because the sine in the 3d and 4th quadrants, and the cosine in the 2d and 3d quadrants are negative, the output signal is reversed as shown by the block -1. This reversal is accomplished by reversing the supply voltage to the output signal transducer, for example a strain gauge or slidewire. An adjustable suppression voltage in the measuring circuit is provided to balance out the constant term.

The two co-ordinates each include a complete self-balancing system having an amplifier, servo motor, and slidewire. Individual zero and span adjustments are provided for each axis, and serve the purpose of centering the plot and setting the proper scale factors. The output signal is connected to both axes; the sampling is performed by short-circuiting the amplifier phase of the motors except during their sampling interval.

Figure 2 shows the entire system. Viewed clockwise from the upper right hand corner are the recorder, the control box, the sine wave generator, and the speed-setting potentiometer. Amplitude and level adjustments of the sine wave all are made from the front panel of the drive unit. The pneumatic sine-wave generator is a

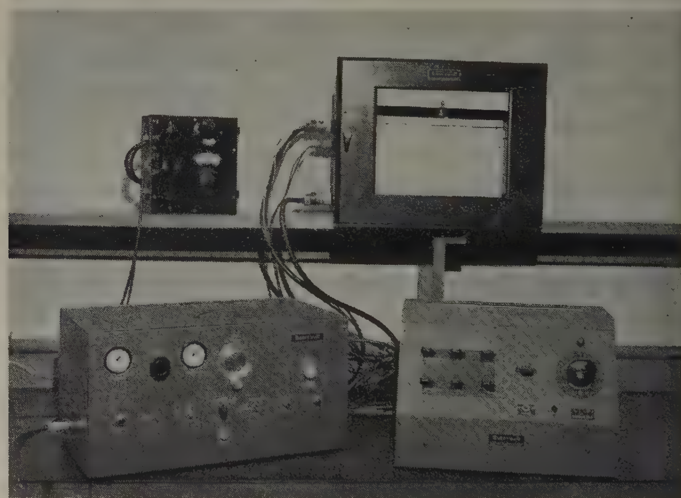

Figure 2. View of entire system

closed-loop device which produces a test signal of very low distortion over a wide range of amplitudes (0.05 to 7 pounds per square inch) and mean pressure levels (1 to 19 pounds per square inch). The test frequency, determined by the potentiometer setting, is maintained by a tachometer feedback servo. This achieves a considerable time saving by enabling the accurate and rapid selection of the desired test frequency.

Digest of paper 53-293, "An Automatic Transfer Function Measuring and Recording System," recommended by the AIEE Committee on Instruments and Measurements and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Summer General Meeting, Atlantic City, N. J., June 15–19, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

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The Permeability of Silicon-Iron

EBERHARD BOTH

THE MOST SIGNIFICANT characteristic for core materials to be used in communication transformers is the initial permeability, which should be as high as possible and exhibit a minimum change versus the exciting field strength. These requirements are dictated by the necessity to keep signal attenuation and distortion in these transformers to a minimum, and by the characteristic behavior of magnetic materials at extremely low flux or field strength levels.

Nickel-iron alloys containing 36 to 50 per cent of nickel meet these requirements to a high degree of perfection. However, since nickel continues to be in short supply, the possibility of achieving similar properties in silicon-iron alloys is of considerable practical interest.

Such an alloy was first developed in 1941 by the author and his associates, most notably Dr. F. Assmus, at the Vacuumschmelze AG in Hanau, Germany. The material, known commercially as Trafoperm *25N1*, possesses an initial permeability between 800 and 1,000 and the average increase in permeability for fields up to 100 millioersteds is about 0.3 per cent per millioersted. The production process differs from the one used to obtain grain-oriented silicon-iron for power transformers by a higher degree of cold reduction and a final anneal at a lower temperature.

In a recent series of experiments, toroidal test cores wound from 3.25-per-cent silicon-iron tape 0.5 inch wide and 5 mils as well as 2 mils thick were hydrogen annealed at temperatures ranging from 600 to 900 degrees centigrade. The material was obtained from the Allegheny Ludlum Steel Corporation, Brackenridge, Pa.; it was produced from fully annealed and grain-oriented 14-mil strip available from this company under the trade name of "Silectron," by cold-rolling to the final thickness without further anneal, thus resulting in a cold reduction of about 64 per cent for the 5-mil tape and about 86 per cent for the 2-mil tape.

The permeability of the annealed cores was measured at field strength values ranging from 10 micro-oersteds to 100 millioersteds. The tests were extended to the unusually low field strength of 10 micro-oersteds (or a flux density of 5 to 20 milligausses) in order to obtain permeability values more truly deserving the epithet "initial" than those derived from the extrapolation of tests taken at and above 5 gausses; the latter can be greatly in error due to the peculiar behavior of the permeability of silicon-iron initially.

The increase in permeability between 10 micro-oersteds and 100 millioersteds is a measure of the hysteresis losses and the attendant distortion; it is recorded here in the form of δ-values, where $\delta = \mu - \mu_0/\mu_0 H \times 100$ per cent per millioersted.

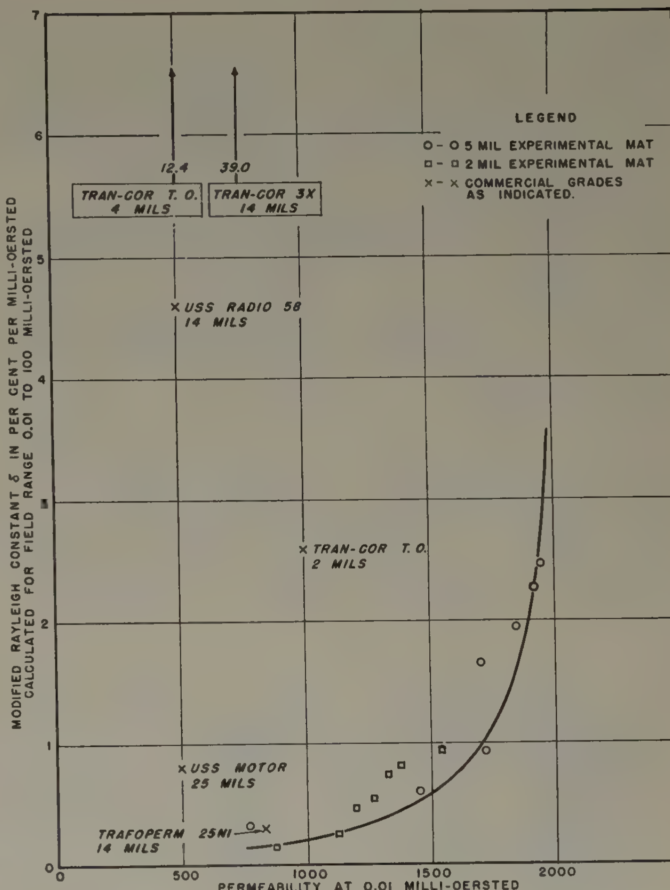

Figure 1. Average slope of the μ versus H curve between 0.01 and 100 millioersteds for various experimental and commercial silicon-iron materials, plotted versus their initial permeability

In Figure 1, the δ-values are plotted versus the permeability at 10 micro-oersteds with the cores made from 5-mil material represented by circles, those from the 2-mil material by squares. Commercial grade silicon-iron materials are included for comparison, in order to show that these, excellent as they are for power transformers, do not qualify for communication transformers on account of their high δ-values and low initial permeability.

It can be concluded from the results shown that magnetic characteristics suitable for communication transformers can be achieved in silicon-iron alloys by special production techniques. An initial permeability of 1,500 together with a δ-value of about 0.5 per cent per millioersted appears to be sufficiently close to the corresponding characteristics of nickel-iron which are $\mu_0 = 2{,}000$ and $\delta = 0.2$ per cent per millioersted that such a material can be used as a substitute in a large number of applications.

Digest of paper 53-259, "The Permeability of Silicon-Iron at Very Low Flux Densities," recommended by the AIEE Committee on Basic Sciences and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Summer General Meeting, Atlantic City, N. J., June 15–19, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

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Techniques in Handling Load Regulating Problems

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RECENT UNPRECEDENTED load growth has stimulated parallel operation to such an extent that there are now only six major interconnections in the United States. The operation of these vast grids has brought two major problems into sharp focus:

1. Permissible scheduled loading on critical arterial tie lines is being reduced by the use of increasingly large cyclic swings.
2. Appreciable savings are being lost by the inability of operating personnel to maintain the loading on an increasing number of stations and units in accordance with incremental costs.

The latest techniques in applying automatic load control have permitted the solution to both these problems.

It is now generally recognized that each system's responsibility to the interconnection involves adjusting its generation to compensate for its own customer load changes. In the early days when interconnections were small it was possible to detect a change in frequency for every major customer load change. Under this condition either manual or automatic control in response to system frequency variations was quite satisfactory.

Present-day operation under interconnected conditions differs from the earlier days. The frequency deviation caused by a load change on any one system is now much smaller because of the larger inertia of the interconnection. Consequently, there is less governor action and many of the customer load changes which were partially absorbed by the frequency-correcting mechanism of the governors now appear on the tie lines. Thus, when analyzing load variations on a typical uncontrolled tie line between two large systems, fast fluctuations of a cyclic nature are often encountered in addition to drifts in the average value.

The ultimate solution to the load regulating problem must be based on the fact that there are two different types of customer load variations which cause tie-line load changes. This article refers to the fast load fluctuations of a cyclic nature as fringe changes, whereas drifts in the average tie-line load are designated as sustained load changes. It is now accepted practice on most systems to control automatically in response to sustained load changes. This is designated as sustained control. If it is necessary to control automatically in response to fringe load changes, a new type of control action is required with continuous response that recognizes fast load fluctuations. Controlling automatically in response to fringe changes should be investigated if either of the following conditions should occur:

1. If the fringe load changes limit the maximum scheduled power transfer on the tie lines.
2. If the rate of change of generation in response to sustained load changes approaches the rate of the fringe load changes.

Under this latter condition the generators are usually over-correcting unless fringe control action is used.

The most important function of fringe control is to permit scheduling tie-line power flows closer to capability limits. This is accomplished by producing a temporary change in generation which approximates that which the frequency-correcting mechanism of the governors contributed when the interconnections were small. Fringe control provides the most satisfactory method for spreading the regulation so that a large number of units in several stations can respond simultaneously to reduce the effect of fast customer load changes until the stations correcting the sustained changes have had an opportunity to absorb the load variation. On steam units, fringe limits are provided so that the fringe correction can be made almost instantaneously inside an adjustable but rather narrow regulating band that is effective only for fringe control action.

From an operating standpoint, it is highly desirable that the percentage of fringe and sustained control action assigned to the regulating stations be independently adjustable. For example, one operating requirement might be to maintain constant integrated output from certain steam plants over a period of time, but utilize their ability to respond instantly to fringe load changes. Some less efficient stations then can absorb the sustained load changes. By keeping the two control actions separately adjustable, it is possible to use the sustained control to follow the most efficient loading schedule for the system. Thus, the regulating units at any instant can be those which should be taking the next increment from a cost standpoint.

Automatic following of economic loading schedules is possible because a definite percentage of the regulating burden now can be assigned to each station independently. With this new development in sustained control, slow response at one station no longer affects the response at the other regulating stations. Because of varying fuel costs, line losses, and maintenance on major equipment, a fixed program control for the stations is not sufficiently flexible to meet changing system conditions. Consequently, the loading schedule is determined by setters provided on consoles. A dispatcher's console carries out loading schedules on the stations, whereas similar consoles at the stations maintain assigned schedules on the units. Thus, the entire system can be loaded automatically in accordance with a predetermined schedule.

Digest of paper 53-147, "Techniques in Handling Load Regulating Problems on Interconnected Power Systems," recommended by the AIEE Committee on Power Generation and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 19–22, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

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The Nature of Nuclear Power

J. W. LANDIS

The various types of nuclear reactors which can be used with the advantages and disadvantages of each, the abundance of nuclear versus fossil fuels, and the cost of nuclear power are discussed.

NUCLEAR POWER refers to energy created by the process of fission. It is well known that fission is the splitting up of a heavy nucleus, after impregnation by a neutron, into two roughly equal fragments and several extra neutrons. Concomitantly, beta and gamma radiations are given off. The three common fissionable materials are Uranium 235, Plutonium 239 and Uranium 233. The division of energy among the various products for a typical Uranium 235 fission is as follows:

	Megelectron Volts
Kinetic energy of fission fragments	162
Neutrino energy	11
Kinetic energy of fission neutrons	6
Instantaneous gamma energy	6
Beta decay energy	5
Gamma decay energy	5

From these data it is immediately discernible that the bulk of fission energy takes the form of heat and that the maximum electric energy obtainable per fission is 5 megelectron volts. Since only a fraction of the beta particles could be collected in any known fission configuration, however, the practical limit of direct electric energy is much lower—almost insignificant. For this reason little hope is held out for direct conversion of nuclear energy to electricity. Several firms, notably the Radio Corporation of America, hold patents on direct conversion processes, but no power applications are envisaged.

To utilize fission energy on a macroscopic scale, a nuclear

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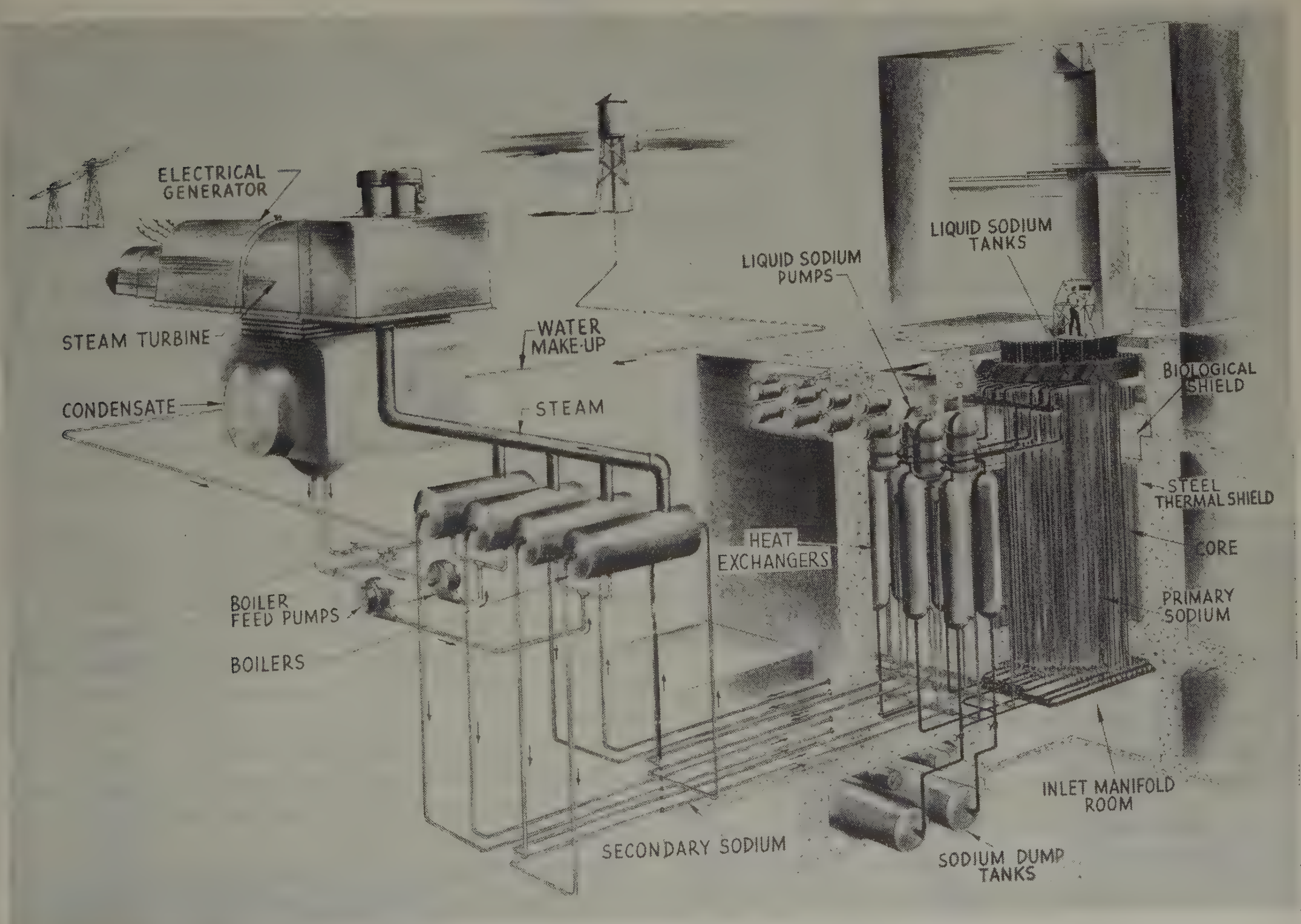

Figure 1. A typical nuclear central station power plant as seen by an artist following one preliminary design

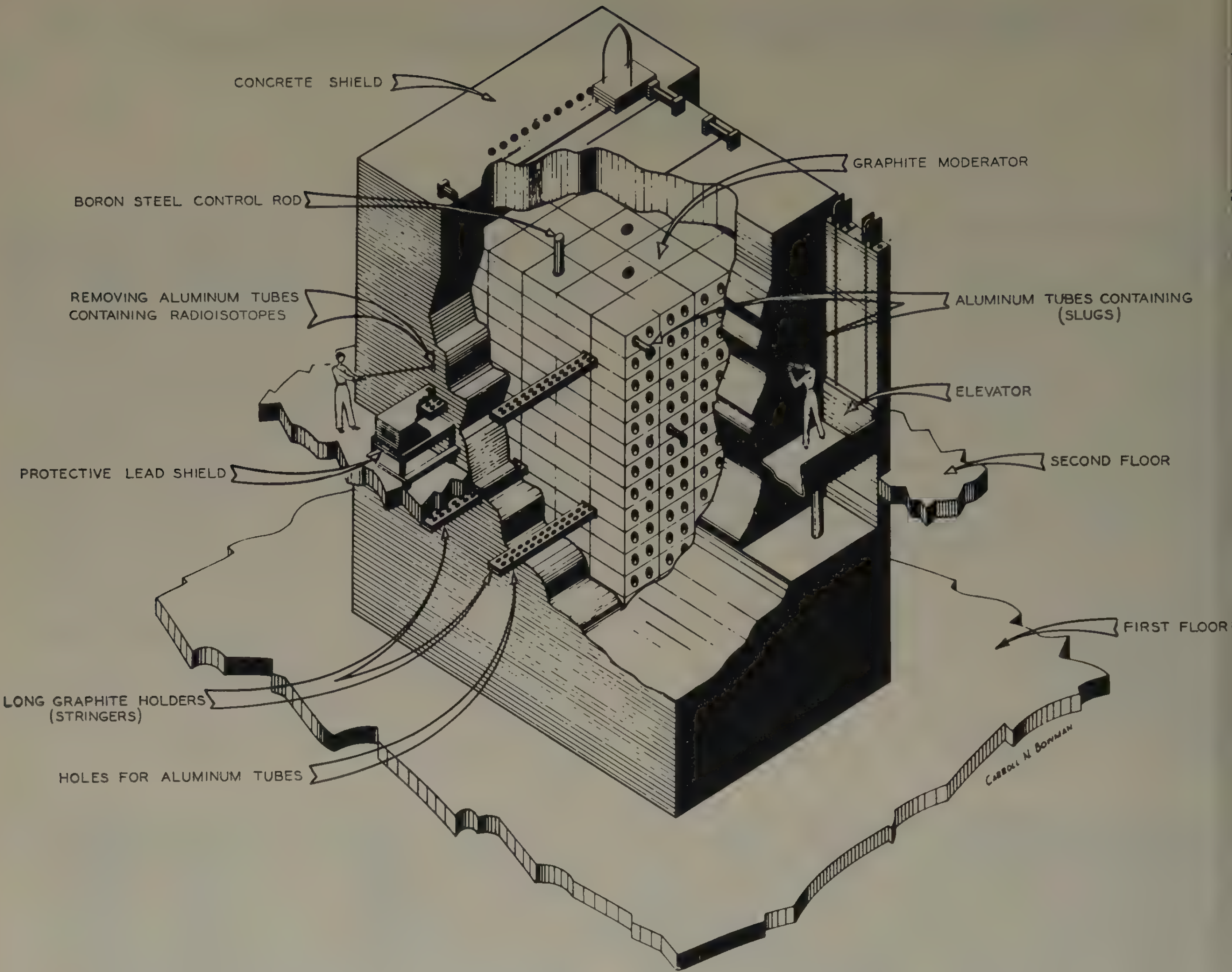

Figure 2. Nuclear reactor—uranium "pile"

reactor is employed. A nuclear reactor is a device to initiate, maintain, and control a fission chain reaction, producing heat gradually not explosively. When it replaces the boiler of a conventional power plant, then the plant becomes a nuclear power plant. The fundamentals of reactor design are undoubtedly familiar. Two of the many variations possible are shown in Figures 1 and 2.

The first major question encountered, therefore, in any discussion of the nature of nuclear power is what kind of reactor will be used.

Nuclear reactors may be classified in any of the following ways. Although other breakdowns are possible, these are the major ones:

1. Fast versus thermal
2. Heterogeneous versus homogeneous
3. Nonregenerative versus regenerative
4. Ordinary coolants versus liquid-metal coolants

A fast reactor utilizes the nascent neutrons from fissioning nuclei directly; that is, they are collided with secondary fissionable material before they have lost much of their energy. A thermal reactor employs a moderator to slow the neutrons down before they are collided with secondary fissionable material. Of course, this is a statistical differentiation. Some fast fissions occur in a thermal reactor and vice versa, but the numbers are relatively small.

A heterogeneous reactor is one which separates the fuel from the moderator and the coolant. Usually the fuel is fabricated in definite shapes. A homogeneous reactor mixes all three (or two in the case of the fast type) intimately, often in liquid form.

A nonregenerative reactor is one which "burns" nuclear fuel but does not replace it. A regenerative reactor replaces part or all of what it burns, by transmuting fertile material to fissionable material. The special type of regenerative reactor which replaces all of what it burns, and which might eventually be made to produce more than it burns, is the breeder.

Liquid-metal coolants permit operation at higher temperatures than do ordinary coolants. This tends to increase over-all efficiency and to decrease the turbogenerator investment required.

Much development work remains to be done before it can be demonstrated conclusively which combination of these categories is best suited for the production of power. This fact is exemplified by the first-year reports of the first

four teams in the Industrial Participation Program. The reports* reflect a diversity of opinion on this subject both within and outside the Atomic Energy Commission (AEC).

Please note that these designs are for dual-purpose reactors only— that is, reactors producing both plutonium and power. The Program recently has been directed toward power-only reactors and new designs undoubtedly will be forthcoming as the studies continue. A fifth group was added to the Program last year (Pioneer Service and Engineering Company of Chicago and Foster Wheeler Corporation of New York) and is preparing a power-only survey report at this time. Other groups are expected to come into the Program very shortly. At present, 36 companies are active.

The nuclear power plant designs selected by the industrial participation groups are among those considered promising by the AEC as attested by projects now underway:

> The pressurized-water type is being explored by development of the Submarine Thermal Reactor, the prototype of which recently went critical at the National Reactor Testing Station in Idaho, and by various laboratory projects investigating advanced features of design. In addition, studies leading to a pressurized-water large ship reactor have been conducted. Following the recent recommendations of the Department of Defense, the latter are being reoriented to lead to a reactor for a central-station power plant.
>
> The sodium-graphite design proposed by Monsanto Chemical–Union Electric has been carried to an advanced stage by a Commission contractor, North American Aviation, Inc. Sodium cooling has been tried out in connection with the Submarine Intermediate Reactor being developed and constructed by the Knolls Atomic Power Laboratory.
>
> That a fast breeder design is practicable recently has been proved by the Argonne National Laboratory (ANL). The Experimental Breeder Reactor, constructed at the National Reactor Testing Station under ANL supervision, and operating in the fast neutron range with sodium-potassium coolant, has just been announced to be successful.

One type of reactor not covered by the first industrial participation studies is the homogeneous reactor. Successful operation of the Homogeneous Reactor Experiment (HRE) at the Oak Ridge National Laboratory since the spring of 1952 increases confidence in this type. Oak Ridge

* Unclassified versions of these reports were released to the public on May 31st and can be purchased from the Government Printing Office for $.25. Table I summarizes the designs studied by these groups to date.

Table I. Reactor Designs Studied by Industrial Participation Contractors for Regenerative Dual-Purpose Reactors

Group	Reactor Designation	Neutron Energy	Fuel	Moderator	Coolant	Temperature, Degrees Fahrenheit In	Temperature, Degrees Fahrenheit Out	Power Gross Heat in Megawatts	Power Net Capacity in Megawatts	Cylindrical Core Diameter in Feet	Cylindrical Core Height in Feet	Pressure Vessel	Estimated Cost of Plant Total Millions of Dollars	Estimated Cost of Plant Dollars per Kw	Remarks
Commonwealth Edison and Public Service of Northern Illinois	Helium-graphite reactor (HGR)	Thermal	Natural uranium	Graphite	Helium	384	650	350	47	35	20	Sphere, 44 feet diam., 147 pounds per square inch	40	850	Short-term development. Not promising
	Pressurized heavy water (PHW)	Thermal	Natural uranium	Heavy water	Heavy water	388	440	1,064	211			Sphere, 20 feet diam., 800 pounds per square inch	118	560	Short-term development. Heavy water at $80 per pound
	Pressurized light water (PLW)	Thermal	Slightly enriched uranium	Light water	Light water	369	440	1,243	246			Cylinder, 12 feet deep, 39 feet high, 800 pounds per square inch	73	297	Short-term development
Bechtel and Pacific Gas and Electric	Pressurized heavy and light water (PHLW)	Thermal	Natural uranium	Heavy water	Light water	384	500	500	101	13	11	Not designed	41	405	Short-term development. Heavy water assumed to cost $80 per pound
	Fast breeder reactor (FBR)	Fast	Highly enriched uranium	None	Sodium	600	900	500	145	3	3	Not required	51	350	Long-term development. Considerable development needed
Monsanto and Union Electric	Sodium-graphite reactor (SGR)	Thermal	Slightly enriched uranium, 0.83 per cent, 232 tons	Graphite	Sodium	300	605	1,000	210	35 (octagonal prism)	20	Not required	100	476	Medium-term development. Some development of liquid metal technology needed
		Thermal	Slightly enriched uranium, 0.95 per cent, 232 tons	Graphite	Sodium	300	900	3,000	554			Not required	156	282	
		Thermal	Slightly enriched uranium, 232 tons	Graphite	Sodium	300	825	675	125	16 (octagonal prism)	15	Not required	60	480	
Detroit Edison and Dow Chemical Co.	Low melting alloy fuel fast breeder	Fast	Highly enriched uranium or plutonium	None	Sodium	400	1,000	600	200	3	3	Not required	Not yet estimated		Long-term development. Advanced design

Note: All designs call for plutonium production in addition to electric power. Uranium 238 is the fertile material for all.

is proceeding with research and development in this connection and in March of this year utilized the HRE to operate a 150-kw electric power plant.

Because it would provide high power density, facile processing and reconstitution of the fuel, and increase the existing fuel supply, the fast homogeneous breeder long was considered to be the ultimate objective of reactor development. Lately, however, reactor designers have learned that breeders may require such a large fuel investment that the fuel tied up would more than offset the fuel consumed in certain regenerators over a significant period of time. As a matter of fact, any fast reactor (and most breeders fall in this category) may require too much initial fuel investment to make it economical. Moreover, completing the reversal of form, maintenance is still so big a question with regard to the operation of those homogeneous reactors which circulate the fuel outside the core that even the trend toward fluid fuels is being re-examined.

The foregoing discussion emphasizes that power-reactor design is in a state of flux. The best that can be done in any unclassified discussion at this time is to present lists of the advantages and disadvantages of the various reactor classifications given above. Which of these factors will be most important cannot be predicted. These lists, incidentally, are the outgrowth of both AEC and industrial studies. They are by no means complete, but will serve as an indication of the large number of problems which arise in reactor design.

List I

Fast	Thermal
Large fuel investment required	Small fuel investment required
Control problems relatively difficult	
No moderator needed	Moderator may be expensive
Need fuel diluent	
High power density per unit volume	Low power density per unit volume for high-Z moderators
Circulating fuel impractical because of high concentration of fuel required	Heat removal ordinarily not difficult
Limited choice of coolants complicates heat removal	Wider choice of coolants simplifies heat removal
Large minimum critical mass	Small minimum critical mass

List II

Heterogeneous	Homogeneous (Fluid Fuels)
Fabrication of complex fuel shapes sometimes necessary	Fuel usually supplied in simplified, sometimes liquid form
Chemical processing involves removal of fuel elements with expensive and complicated apparatus, and special handling throughout various processing steps	Fuel may be processed continuously. Selective removal of fission products and plutonium possible without handling uranium
Fission products may build up to dangerous concentrations	Fission products do not build up
No fuel-circulation corrosion problems	Corrosion and container difficulties are paramount
Radiation damage may limit burnout	Fuel may be added continuously to extend burnout

List III

Nonregenerative	Regenerative
Useful only in certain power plants where value of fuel consumed is outweighed by unusual advantages of nuclear power	Replaces part or all of fuel consumed, but sometimes reclamation is expensive
Burnout limited to 1,000 megawatt-days/ton per cycle	Burnout is limited by products desired, but usually is greater than for nonregenerative case
Limits nuclear-fuel reserves to between $1/_6$ and $1/_7$ energy content of conventional-fuel reserves	Stretches nuclear-fuel reserves to 23 times energy content of conventional-fuel reserves

List IV

Ordinary Coolants (For example, Water)	Liquid-Metal Coolants (For example, Sodium)
Require considerable pressurization for operation at power-plant temperatures	Permit high-temperature operation without pressurization
	Become highly radioactive
Material is cheap	Possess higher thermal conductivities but lower heat capacities than does water
Losses are not important	Pumping costs are relatively high
	Special pumps required
Conventional equipment often can be used	Special tubing and heat exchangers required to prevent leaks

A second major question with regard to the nature of nuclear power concerns the abundance of nuclear fuels. This question may be split into two parts:

1. What kind of fuel will be used?
2. Is enough available to support a large-scale industry?

The basic nuclear fuels are uranium and thorium. These contain or can be converted into fissionable material: Uranium 235, Plutonium 239, Uranium 233. Uranium

Table II. World Fuel Reserves as of January 1, 1950

Material	Reserves	Source	Unit Energy	Total Energy
Crude oil	610–62 ≈ 550 billion barrels	Weeks and Moulton	6,400,000 Btu/barrel	35×10^{17} Btu
Natural gasoline	11.5 billion barrels	American Petroleum Institute (assuming the same ratio $\frac{\text{World}}{\text{United States}}$ as for crude oil)*	6,400,000 Btu/barrel or 4,300,000 Btu/barrel	0.74×10^{17} Btu or 0.49×10^{17} Btu
Shale oil	620 billion barrels	United States Bureau of Mines (assuming the same ratio $\frac{\text{World}}{\text{United States}}$ as for crude oil	6,400,000 Btu/barrel	40×10^{17} Btu
Natural gas	560 trillion cubic feet	American Gas Association (assuming same ratio $\frac{\text{World}}{\text{United States}}$ as for crude oil)	1,000 Btu/cubic foot	6×10^{17} Btu
				$\approx82\times10^{17}$ Btu subtotal fluid fuels
Coal	3,482 billion tons	United States Bureau of Mines United States Geological Survey	Anthracite 12,700 Btu/pound Low-volatile bituminous 14,000 Btu/pound High-volatile bituminous 13,500 Btu/pound Sub-bituminous 9,500 Btu/pound Lignite 6,700 Btu/pound	72×10^{18} Btu
				$\approx80\times10^{18}$ Btu total conventional fuel
Uranium	25×10^6 tons	AEC (Division of Raw Materials)	200 megelectron volts/fission 3.5×10^{10} Btu/pound = 1,300 tons of coal	17×10^{20} Btu
Thorium	1×10^6 tons	AEC (Division of Raw Materials)	200 megelectron volts/fission 3.5×10^{10} Btu/pound = 1,300 tons of coal	0.71×10^{20} Btu
				$\approx18\times10^{20}$ Btu total nuclear fuels

* 26.2 per cent.

Note: Approximately 23 times as much energy in the world's nuclear fuel reserves as in conventional-fuel reserves.
All this assumes complete "burn-up"—or breeding or conversion ratio of 1:1. If no conversion assumed, divide by 140.

235 is the only fissionable material found in nature; it constitutes one part in every 140 parts of natural uranium. The remaining 139 parts are Uranium 238. Plutonium 239 is produced from Uranium 238 by suitable transmutations. This is what the Hanford reactors are operated to accomplish. In a similar way Uranium 233 can be produced from thorium.

Uranium and thorium are not as plentiful in terms of total mass minable at a reasonable cost as are the fossil fuels, coal, oil, and natural gas. Since a breeding or conversion ratio of one to one is attainable, however, the energy in one pound of uranium is so much greater than that in one pound of coal (one pound of uranium is equivalent to 1,300 tons of coal) that the total energy residual in the uranium and thorium reserves is approximately 23 times as great as the total energy residual in the fossil-fuel reserves. A breakdown of this comparison is given in Table II. The obvious conclusion is that availability of raw materials will place no limitation on the expansion of the budding nuclear power industry.

A third and last major question has to do with the cost of nuclear power. Paper studies indicate that several reactor designs come to within a few mills per kilowatt-hour of the national average for the cost of conventional power production. In computing nuclear power costs the following assumptions are made:

1. That ore costs $20 a pound and that enrichment is based on this price.
2. That nuclear reactors for power plants can be operated for at least 20 years.
3. That standard electrical utility bookkeeping applies—namely, 5.5 per cent for profit, 4.8 per cent for taxes and insurance, and 3.5 per cent for amortization (20-year sinking fund).
4. That nuclear power will be used for base load with a plant factor of 80 per cent.

Thus, assuming that a reasonable amount of technical progress comes to pass in the interim, appreciable blocks of competitive power with nuclear reactors should be produced by the year 1963. It is relatively certain that there will be no fuel shortage to curtail production, but the particular designs which may be desired have not as yet been crystallized.

Unique Outdoor Hydroelectric Plant

H. E. RHOADES
MEMBER AIEE

This plant is the first hydroelectric installation in the upper midwest area subject to a temperature range of +105 to −30 degrees Fahrenheit. Built into the masonry substructure of a retired 10-unit plant, economics, climate, and the site dictated the incorporation of design features and innovations to assure all-weather operation.

LOCATED a half-mile below the Falls of St. Anthony, on the Mississippi River at Minneapolis, Minn., Lower Dam Hydro Plant consists of ten individually housed, 800-kw, vertical synchronous units directly connected to 1,140-horsepower, fixed-blade, propeller-type turbines operating at 23.5-foot head. Generators are protected from frosting and condensation by thermostatically controlled electric heaters, drip baffles, and drains. Generator-intake and -exhaust ventilating air ducts are relatively long, with 180-degree bends and screened, downward-faced openings to prevent entrance of snow, rain, and other foreign matter. Thrust bearings are forced-oil-cooled with heat exchanger submerged in each headrace. D-c motors supplied from the control battery relieve vital equipment from dependence on a-c station auxiliary supply, and oil-actuated brakes eliminate the freezing hazard inherent in a compressed air system.

The plant is remotely supervised and controlled through a multiple conductor, synthetic insulated underground cable from another hydro plant 1/2 mile upstream. Any combination of units can be selected optionally for full automatic operation controlled by a float in the head water pool.

Running or shut down, the units have not been adversely affected by any weather experienced since the first unit went into service in July 1952.

SITE AND REASON FOR RECONSTRUCTION

THE Engineer Corps, Department of the Army, is now engaged in an extension of the Mississippi River 9-foot navigation channel at Minneapolis, Minn., from its present terminus about 1 mile below the Falls of St. Anthony to harbor areas in North Minneapolis upstream from the Falls. The Government's plan, known as the Upper

Full text of paper 53-220, "Unique Outdoor Hydroelectric Plant," recommended by the AIEE Committee on Power Generation and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Summer General Meeting, Atlantic City, N. J., June 15–19, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

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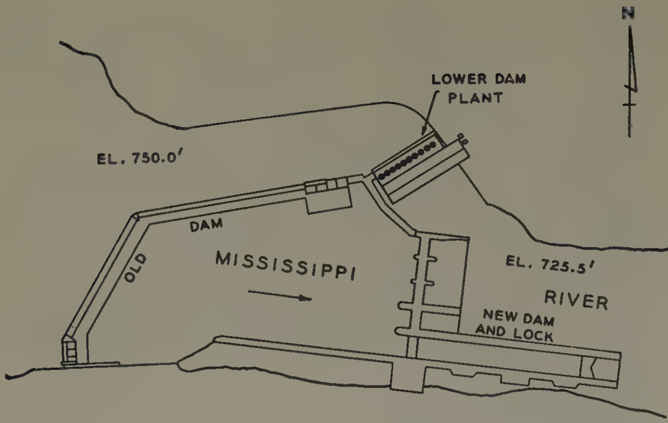


Figure 1. Plan of plant site, old dam which will be removed, and new government dam and lock

Harbor Navigation Project, involves channel dredging, construction of a lower lock with a 25-foot lift and a new dam adjoining the Lower Dam Plant, an upper lock with a 50-foot lift through the Falls of St. Anthony, and alteration of railroad and city bridges to provide navigational clearances.

The old Lower Dam Hydroelectric Plant, a 10-unit 35-cycle installation, built in 1897 for street railway service, was shut down in July 1950 to make way for an early phase of the Government's construction program which included lowering the plant tailrace water level $4^1/_2$ feet.

The condition of the 53-year-old, horizontal, revolving armature generators, associated electric and mechanical equipment, and the increased head were principal factors in the decision to remove the plant from street railway service and reconstruct it for interconnected system operation at 60 cycles.

Utilization of the old plant substructure was desirable economically, and of several designs considered, the most feasible was the installation of vertical single-runner units centered on the old multiple-runner turbine settings, outside the existing powerhouse.

Remodeling and construction work from shutdown of the old plant to in-service date of the first new unit in July 1952 required 24 months.

COST COMPARISON FACTORS

To determine whether the generator installation should be indoor or outdoor, synchronous or induction, these factors were considered:

1. New powerhouse building for indoor generators.
2. Weatherproof housings for outdoor generators.
3. Additional heaters for outdoor units.
4. Alterations to existing powerhouse for indoor switchgear.
5. Average generator erection costs.
6. Additional d-c equipment and control required for synchronous generators.
7. Amortized charge against induction generators for a minimum 2-per-cent lower efficiency.
8. 9,000 kva of static capacitors for induction generators.
9. Amortized credit to induction generators for static capacitor reactive kilovolt-amperes when plant is shut down.
10. Lower-interrupting-capacity circuit breakers for induction generators if circuit breaker opening on fault is delayed eight cycles and transformer impedance increased to 8 per cent.

The estimated value of each factor is listed categorically in Table I. The totals of each column were added to manufacturers' bids, and cost comparison on this basis was a major factor in the decision to install outdoor synchronous units.

Table I. Cost Comparison Factors, Estimated Values in Dollars

	800 Kw Synchronous		800 Kw Induction	
	Indoor	Outdoor	Indoor	Outdoor
New powerhouse building	$75,000		$75,000	
Housings		$40,000		$40,000
Heaters		1,000		1,000
Switch house		10,000		10,000
Generator erection	17,500	21,000	16,000	20,000
Equipment and control	14,000	14,000		
Reduced efficiency charge			30,000	30,000
Capacitors—9000 kva			45,000	45,000
Capacitor kvar availability	10,000	10,000		
Higher interrupting capacity breakers	10,500	10,500		
Total	$127,000	$106,500	$166,000	$146,000

DESIGN AND CONSTRUCTION

Generators. Power is generated by ten outdoor 875-kva 800-kw 225-rpm 4,160-volt 60-cycle vertical generators with direct-connected 125-volt exciters. The generators and housings were designed specifically for the installation and are believed to be the first outdoor hydroelectric units in this climatic area.

The principal weatherproofing features incorporated in the design are

1. Steel weatherproof housing with neoprene-gasketed vertical-joint sponge-rubber compression seals on access door, and bolted-base joint sealed with nonhardening mastic.
2. Ventilating air ducts with extensions and 180-degree bends to eliminate entrance of snow or rain.

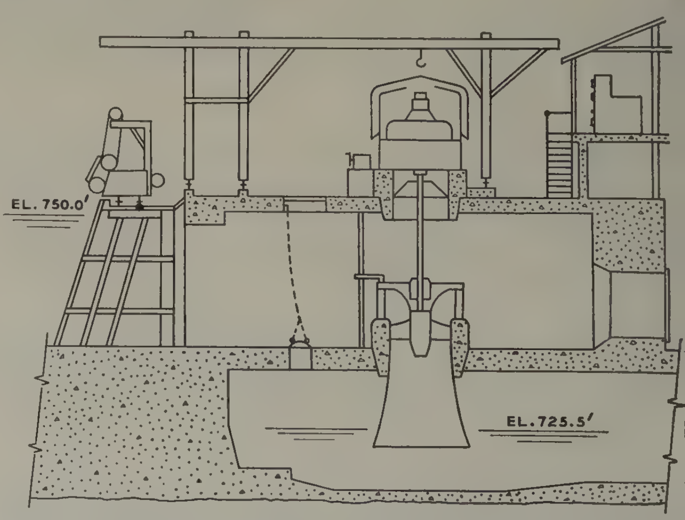


Figure 2. Adaptation of headworks, tailrace, and balcony of old plant to new installation: simplified partial cross section through one unit

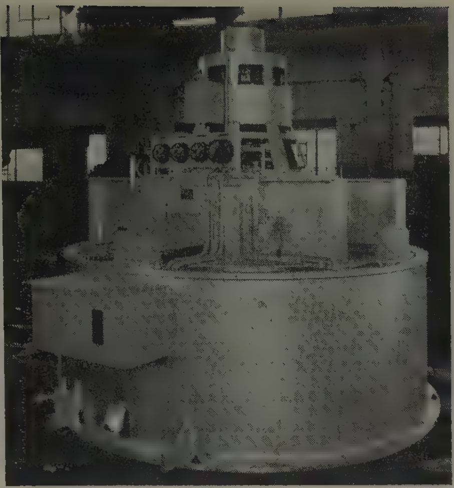


Figure 3. Shop view of generator. Stator terminal connection box on front, bearing-temperature and thrust-tank oil-level indicators above thrust-bearing supports, field failure relay box on exciter, and enclosed centrifugal speed switches above exciter

3. Air-duct openings screened against insects, birds, animals, and wind-blown trash.
4. Thermostatically controlled electric heaters to minimize frosting and condensation.
5. Drip baffles and drains to shield generator and exciter from condensed moisture.

Generator and exciter frames, bearing brackets, and sole plates are of steel plate, fabricated by welding. The field spider is the only large casting in the generator, and is an inverted-cup type to bring the generator shaft coupling face above the generator base. This feature permits moving the housed generating unit to one side without opening or lifting, for removal of the turbine shaft and runner. Generators have self-aligning, articulated-shoe thrust bearings designed for 51,000 pounds external load.

The original design contemplated cooling both generator and thrust bearing with air, but proved impractical for the thrust bearing. A copper tube heat exchanger was submerged in each headrace, with no fittings below water, and oil from the thrust bearing oil tank circulated by a positive pressure pump driven by a 3-phase 1/2-horsepower motor which starts and stops with closing and opening of the generator circuit breaker. Piping for the heat exchanger is so arranged and vented that no serious loss of thrust bearing oil will occur if a leak develops.

Turbines. The turbines are 1,140-horsepower, direct-connected, fixed-blade propeller type, with a discharge capacity of 486 cubic feet per second at efficient gate and 23.5-foot head. Each turbine has a submerged lignum vitae guide bearing on the upper headcover, designed originally for water lubrication. Initial operation disclosed excessive wear of the lignum vitae bearing blocks and scoring of the stainless-steel sleeve upon which these blocks bear.

Tests indicated a maximum vacuum of 3.3 inches of mercury in the bearing housing at 60-per-cent gate opening, which presumably drew in large quantities of water, deposited silt within the bearing box, and resulted in rapid wear of blocks and sleeve.

Of several suggested remedies, two are being tested. On nine units, flexible synthetic-rubber shaft seals have been placed in the top and bottom of the bearing box and the box filled with a lithium-soap-base grease. Additional lubricant can be added through a pipe which extends above the operating deck. The tenth unit is equipped with an oil-lubricated babbitt bearing of the dry-well type, accomplished by extending a steel cone from the operating deck to the turbine upper headcover, with all joints gasketed or welded. The dry well is provided with an automatic sump pump.

Gate Actuators. There are no governors on these units. The gates are operated by an individual d-c motor driving a double worm-reduction gear, and require 15 to 20 seconds from full-close to full-open position or vice versa. These mechanisms are equipped with torque switches to prevent damage to the motor, gates, or mechanism, if foreign objects become lodged in the gates. D-c motors were chosen to eliminate dependence on an a-c source which might be lost at a critical period.

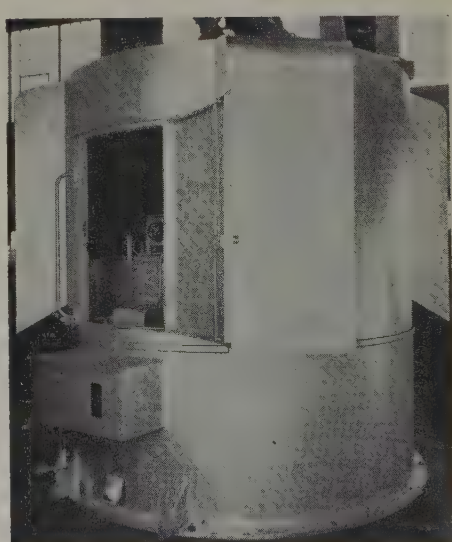
The gate-operating mechanism has two limit switches; the first stops gate opening travel at 40 per cent and returns control to the remote station operator, the second limit switch can be set for any value up to 100-per-cent gate.

Brakes. Each generator has two piston-type oil-actuated brakes which are applied automatically by a solenoid-operated valve when the gates are fully closed and machine speed has dropped to 50 per cent.

The braking system is supplied by a common header at 100 pounds per square inch from a d-c motor-driven pump with a small air-cushion chamber and an unpressurized return tank. Air was ruled out as a braking medium to eliminate condensate freezing in cold weather, and the oil used in the brake system is a type developed for winter use in outdoor hydraulic cylinder applications for bulldozers and dump trucks. The generator rotor can be raised by a manually operated jacking pump after shutting off the individual generator feed and return brake lines.

All piping and fittings in the braking system are welded throughout, with the exception of ground joint unions in the supply and return lines to each generator. That part of the brake piping subjected to jacking-pump pressure is designed for 1,000 pounds per square inch.

Figure 4. Shop view with outdoor housing in place over the generator. Housing fits in annular groove of generator frame, sealed with mastic after bolting. Note long air discharge ducts



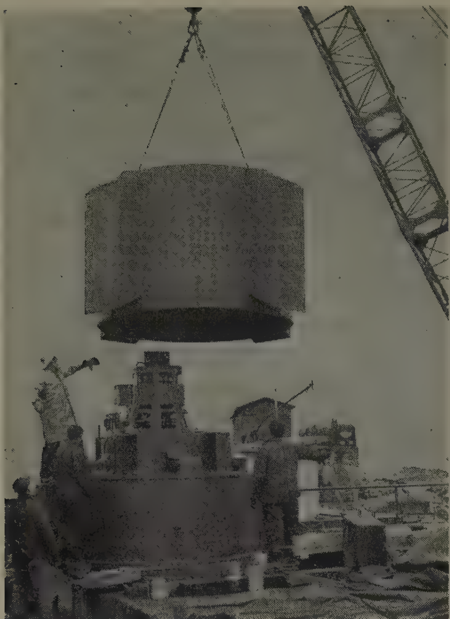


Figure 5. Lowering the housing on the generator during installation

Major Electric Connections. The 4,160-volt generator bus is divided into two sections which may be tied together by a nonload-breaking dummy circuit breaker. Normally this tie is in the open position. To each section of the 4,160-volt bus are connected five generators, and an outdoor 3-phase 3,750/4,687-kva 4.16–13.8-kv oil-insulated forced-air-cooled transformer connected grounded Y on the low-voltage side, delta on the high-voltage side. Each of these banks is connected on the high-voltage side to a 3-phase lead-covered gas-filled cable, which runs in tunnels and underground duct work to tap into an underground cable between the controlling plant and a distribution substation. Built into a steel enclosure on the front of each transformer bank is a double-throw 3-phase gang-operated disconnect mechanism by which either transformer can be connected to its own or the other 13.8-kv line. The disconnects are interlocked to prevent operation unless the bank low-voltage breaker is open, and they have arc chutes for breaking transformer magnetizing current.

The transformer and generator draw-out-type air circuit breakers, exciter rheostats, protective and remote control equipment, and the 4,160-volt bus are mounted in 23 metal-clad switchgear cubicles bolted together in a continuous structure. Two units are required for each of the generators and one each for the transformer banks and the bus tie dummy circuit breaker. Relays, instruments, meters, and local and transfer control switches are mounted on the front of the switchgear line.

The switchgear, control battery, charging set, annunciator, contactors, and power switches for the gate-operating mechanisms, lighting panel, and terminating panel for a 100-pair control cable are indoors on the unheated control balcony of the old plant. There is also a small electrically heated room for use of maintenance crews.

Station Auxiliary Supply. Station auxiliary power at 120/240 volts is supplied by a bank of two 37.5-kva transformers through disconnecting fuses from the number 2 section of the 4,160-volt bus.

Miscellaneous Auxiliaries. A mechanical trash rack rake with manual travel and motorized rake hoist is mounted on narrow-gauge tracks parallel to the racks. Power for the hoist motor is supplied through a spring-retracting cable reel on the rake with sufficient cable for travel half the length of the rack section. Two plug receptacles on the headworks serve the motor cable.

A manually operated traveling gantry crane, mounted on rails on the headworks, and a part of the original plant equipment, will be electrified for crane travel and equipped with a 5-ton electric hoist. This crane will be served by a cable reel and plug outlets similar to the mechanical trash rack rake.

REMOTE SUPERVISION AND CONTROL

A full complement of instruments and controls is provided at Lower Dam Plant for local control under abnormal conditions but there are no operators as such assigned to the plant. Normal control and supervision is effected remotely through 100-pair 19-gauge synthetic-insulated underground cable which follows the same route as the 13.8-kv cables from the Lower Dam Plant to Main Street Hydro Plant, the controlling station.

Equipment. Supervisory panels at Main Street Plant provide the following:

1. Continuous instrument indication of: watts, vars, and amperes of both transformer banks; single-phase voltage of each bus section; graphic pond level; watts, vars, amperes, and gate position on any two selected units, one on each bus section.
2. Lamp indications of: ten generator and two transformer bank circuit breakers continuously; field rheostat limit, gate limit, unit on float control, and instrument indication and control point, on any two selected units, one on each bus section; nine annunciator alarms.

Operation. To guard against inadvertant operation by induction, short circuits, or grounds, the controlled plant battery is applied to the remote control system by a mechanically coded signal initiated by the controlling station operator, and is automatically disconnected after a 20-second interval.

Figure 6. View of the plant during construction. Outlet transformers at left of the old powerhouse. Generator air intake ducts are flat mushrooms shapes on each side of the generators. Normal pond level will be two feet below the top of the racks

Figure 7. Old powerhouse from downstream side. Note tailrace tunnel openings, new government dam at center, and the old Lower Dam at left center

A unit can be started by remote control if the following conditions prevail at Lower Dam Plant: control transfer switch on "remote," generator circuit breaker open, 50-per-cent speed switch deactivated, exciter field contactor open, exciter field rheostat in cam-positioned prestart position, bearing thermal relays and lockout relays reset, and control power on the remote control system.

Operation of the *start* button at the controlling plant will now pick up the master relay on the selected unit, start an automatic sequence timer, and energize the gate-opening circuit. The gates will open to 40 per cent, where they are stopped by a gate-limit switch. When the machine reaches 95-per-cent synchronous speed, a centrifugally operated speed-switch will close the generator circuit breaker. An auxiliary contact on the generator circuit breaker closes the exciter field contactor and the generator and exciter then build up and lock the unit into step with the system. Field failure relay cannot pick up until generator circuit breaker is closed, and time delay is introduced to allow field to build up after the generator goes on the line. Another auxiliary contact on the generator circuit breaker starts the thrust-bearing cooling system pump. When the exciter field contactor closes, control of the motor-operated exciter rheostat is returned to the remote operator, and when the incomplete sequence timer stops, control of turbine gates also is returned to the remote operator.

Shutdown is approximately the reverse of the starting sequence, and as the generator slows down brakes are applied automatically when the turbine gates are fully closed and the unit has dropped to 50-per-cent speed. A pneumatic timing relay releases the brakes in 30 seconds.

PROTECTION

PROTECTIVE devices result in shutdowns in the following categories:

Normal Load Rejection and Shutdown. Bus overvoltage, time overcurrent, overspeed (285 rpm), or failure of the field contactor to close before the incomplete sequence timer stops, sequentially will close turbine gates to 40 per cent, trip the generator circuit breaker, completely close the turbine gates, and shut down the unit.

Normal Load Rejection, Shutdown, and Lockout. Generator bearing overtemperature will cause the same sequential operation described in the preceding paragraph, plus lockout. In each generator housing are three manually reset thermal relays, one each for generator thrust, and upper and lower guide bearings. Operation of any one of these will trip a manually reset lockout relay on the generator panel.

Emergency Load Rejection, Shutdown, and Lockout. Differential fault, instantaneous overcurrent, phase unbalance, bus section fault, or field failure immediately will trip the generator circuit breaker, causing load rejection, shutdown, and lockout through a separate manually reset lockout relay. A bus section fault or transformer differential fault will trip and lock out a transformer bank, and cause loss of all running machines on the affected bus section. Line overcurrent will cause similar tripping without lockout. If the bus-tie dummy circuit breaker is in the closed position or both transformer banks are connected to one line through their 13.8-kv gang-operated disconnects, a bus section fault, a transformer differential fault, or line overcurrent will affect all equipment on both sections.

Alarms. There are 23 separate alarm signals on the Lower Dam Plant annunciator panel. These are regrouped into nine alarms at the Main Street Plant.

AUTOMATIC OPERATION BY POND LEVEL FLOAT

UPON COMPLETION OF the Upper Harbor Navigation Project, regulations will require maintenance of the pond level between limits of +0.6 and −0.4 feet of normal, within the plant discharge capability.

To eliminate constant vigilance by the remote operator, any combination of units may be selected to operate automatically from a contact-making pond level float. Although all machines on float control will be affected when either float limit is reached, a 5-second maximum time delay cascades each successive gate mechanism operation to reduce demand on the control battery.

Hydroelectric Development

The United Nations Economic Commission for Europe has reported that 16 countries attending its Electric Power Committee session have adopted unanimously a recommendation designed to overcome difficulties which might arise from the development and utilization of rivers of interest to two or more countries. Under the recommendation to European Governments, a State proposing to embark within its own territory on projects which may affect the territory of other States should first inform the States concerned of the nature of the effect. Negotiations could be opened then between the parties in the interest of harmonious hydroelectric development.

Cathode-Ray Synchroscope and Automatic Synchronizer

M. ABDEL-HALIM AHMED
MEMBER AIEE

TODAY ELECTRONICS IS forging a silent evolution in all fields of industry; and the modern tendency in power generating stations is to have the control gear operating electronically whenever possible.

An electronic synchroscope has been developed, consisting essentially of a cathode-ray tube which utilizes the bus-bar voltage to make the beam trace a circle or ellipse. The incoming line voltage is used to give two pulses displaced by 180 degrees, and occurring at certain defined instants of the cycle. The pulses are superimposed on the *Y*-plate deflecting voltage. The circle thus will have two pips as shown in Figure 1, whose positions depend on the instantaneous phase difference between the bus bar and incoming line voltages. When these two voltages have different frequencies the pips will be seen to move round the circle, in the same manner as the pointer of an ordinary synchroscope rotates. At the correct instant for synchronization, when the two voltages are in phase and of equal frequencies, the pips will be stationary at two certain defined points, which can be made to occur exactly on the *Y* axis of the tube by a suitable arrangement of the circuit. One of the pulses may be suppressed to avoid confusion.

The pulses are obtained simply by the use of a small saturated transformer. Correction for the phase displacement of the pulses is effected by adding a phase-shifting circuit, so that the two pips will lie exactly on the *Y* axis at the correct instant for synchronization.

An alternative method is to apply the pulse transformer output to the grid of the tube, which is biased so that the trace disappears when the pulse voltage falls a few volts below the positive peak value. A single rotating spot is seen then to describe a circle on the screen, and the correct instant for synchronization is when the spot is stationary on the upper part of the *Y* axis.

The actually developed experimental synchroscope has proved to be easy to make, adjust, and operate; to be cheap and robust. Its accuracy is the same as normal synchroscopes or even better, and it is not liable to errors, sticking, damage, and so forth.

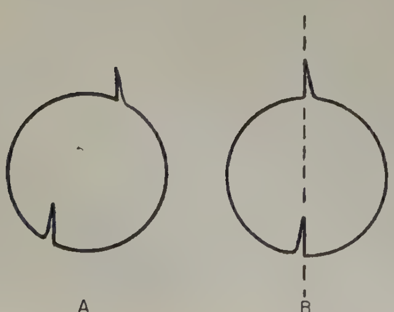


Figure 1. Circular trace appearing on screen of cathode-ray synchroscope

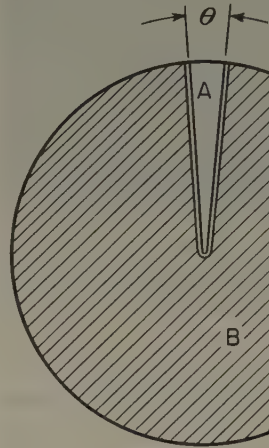


Figure 2. Commutating electrodes of the special cathode-ray tube for the automatic synchronizer

The automatic synchronizer uses a cathode-ray tub[e] working on the rotating-spot principle just outlined. Th[e] tube is a special one in which the beam current, as it trace[s] the ellipse, is commutated by two electrodes *A* and *B* (Figure 2) replacing the screen of a normal tube. Th[e] tube is normally biased beyond cutoff, and when the pulse[s] are applied the positive pulse will cause a current to flow which will be collected by either electrode *A* or *B* depending on the instant at which the positive pulse occurs.

At the correct condition for synchronization, the positiv[e] pulse occurs whenever the beam traverses electrode *A*. The current in *A* is used to operate a relay system whic[h] finally causes the synchronizing circuit breaker to close. When the two voltages differ in phase by more than [a] prescribed allowable limit, *A* will receive no current.

When the two voltages are of different frequencies, th[e] interception point of the beam when the positive puls[e] occurs will be moving, and only a few pulses will fall o[n] electrode *A*. The angular width ϑ of electrode *A* an[d] the angular pulse width *W* are so designed that when th[e] frequency difference does not exceed a certain prescribe[d] allowable value δ, electrode *A* will receive two or mor[e] consecutive pulses, while when the frequency difference exceeds the allowable limit δ, *A* will always receive less tha[n] two consecutive pulses. For this to be satisfied, then: $\vartheta = 4\pi\delta/f$ and $W = \vartheta/2$, f being the frequency of the station.

The relay system connected to electrode *A* is designed t[o] operate only when it receives at least two consecutiv[e] pulses. A convenient and reliable scheme is to connec[t] electrode *A* to a quick-acting slow-releasing relay, whic[h] in turn causes the operation of a slow-acting relay. Th[e] latter will make the synchronizing circuit breaker close.

Digest of paper 53-128, "Cathode-Ray Synchroscope and Automatic Synchronizer" recommended by the AIEE Committee on Instruments and Measurements and approv[ed] by the AIEE Committee on Technical Operations for presentation at the AIEE Win[ter] General Meeting, New York, N. Y., January 19–23, 1953. Scheduled for publicati[on] in AIEE *Transactions*, volume 72, 1953.

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Using Sheet Steel in the Construction of Shielded Rooms

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LOW-LEVEL electronic or electrical measurements are particularly susceptible to errors introduced by external electromagnetic influences. In a laboratory, isolation from such interference usually is achieved by enclosing an area completely in copper or bronze screening. Certain instrumentation, however, requires a higher degree of isolation than can be achieved usually in screened enclosures. Copper sheet has been used ordinarily to construct enclosures to meet these requirements.

The cost of copper rooms is high. Not only is copper an expensive metal in short supply but it also requires tedious and correspondingly costly assembling techniques when used for shielded rooms. For these reasons a study to explore the use of less critical and less expensive materials for the construction of high-performance rooms was made. A review of the theory of shielding, together with an economic comparison of the various metals, pointed to the possible use of sheet steel. The shielding effectiveness of any shielding medium is given by the sum of the reflection from the surfaces of the shield and the absorption loss within the shield. The absorption loss term often is used alone to determine the thickness of metal needed for a specific shielding performance. This can be given by

$$d=0.114\frac{s}{\sqrt{\pi f\mu\rho}} \text{ meters} \quad (1)$$

when s=desired shielding in decibels; f=frequency in cycles per second; μ=absolute permeability of the shield, henry/meter; and ρ=conductivity of the shield, mho/meter.

To verify the predictions pointing to the use of steel, a steel-shielded room was constructed under contract to the United States Naval Civil Engineering Research and Evaluation Laboratory by the Stanford Research Institute.

The room was built of 24-gauge Tran-Cor *72* sheet steel. Calculations, using data supplied by the manufacturer, indicated that this steel should offer an absorption loss of 57 decibels at 15 kc and higher attenuations at higher frequencies. Although Tran-Cor *72* steel was used, other low-carbon steels such as Society of Automotive Engineers *1010* would be satisfactory.

The joints used in fastening the sheets together were made by braking the edges of the sheets into 2-inch 90-degree bends, which then were brazed. The braked edges at the joints provided enough rigidity and structural strength for the room so that no supporting framework, except that necessary to compensate for the weight of the door, was required.

The door was made of the same sheet steel as that used in constructing the wall panels. A solid rubber strip, fitted into a groove in the door jamb, cushioned a bronze contact strip which was soldered to the inner surface of the door around the periphery at the contact area. Slight flexing of the metal as the rubber tubing was compressed upon closing of the door provided a wiping action that kept the contacting surfaces clean. During the tests, iron-to-iron contact was found inadequate for shielding purposes. Its contact resistance was high enough to allow considerable energy leakage through the door closure even when the iron surfaces were newly polished.

Ventilators can consist of "wave-guide below cut-off" ducts arranged in a honeycomb fashion to form the inlet or outlet port.

All electric power entering the room was filtered. The filter box was electrically connected to the outside of the shielded room at only one point to avoid circulating currents in the room walls that would arise if multiple contacts were made.

A magnetic dipole radiator was used to produce the test field. This was chosen because its field in the near region is effective in coupling to a low-impedance conducting sheet, and knowledge of the relative position of the loop in the room and the loop current are sufficient to calibrate and reproduce its performance. Although this technique might be difficult to use at very high frequencies because of the increased driving impedance of the loop, limitations in available funds prevented further exploration at higher frequencies. The results obtained with the loop radiator can be expected to give the minimum effectiveness of the steel as a shielding medium, since the difficulty with which the energy penetrates the shield decreases as the frequency is lowered.

The measured attenuation of the room was found to be 46 decibels at 15 kc and greater than 160 decibels between 1 and 10 megacycles. Values are somewhat less than had been calculated. However, in the calculations a permeability of 1,000 for the steel had been assumed. Subsequent measurements indicated that the relative permeability was closer to 500, which, when used, gave a calculated attenuation of 41 decibels.

The test setup employed was one of shielding against the near field of a partially or completely closed loop carrying a large current. The near field of a current loop being a low-impedance field undergoes little reflection at metal-air boundaries and consequently provided the severest test conditions against which to shield.

Digest of paper 53-197, "The Use of Sheet Steel for the Construction of Shielded Rooms," recommended by the AIEE Committee on Instruments and Measurements and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Summer General Meeting, Atlantic City, N. J., June 15–19, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

A. M. Intrator, now with the General Electric Company, Syracuse, N. Y., was formerly with the United States Naval Civil Engineering Research and Evaluation Laboratory, Port Heuneme, Calif.

The author wishes to express his appreciation to Dr. D. I. Benedict for his efforts in directing the Stanford Research Institute program and to Dr. C. R. Freberg for the suggestions which led to this investigation.

INSTITUTE ACTIVITIES

Middle Eastern District Meeting Stresses Region's Industry in Coal and Oil

The theme of the technical program of the Middle Eastern District Meeting to be held in Charleston, W. Va., September 29–October 1, 1953, will center on electrical aspects of the region's coal, chemical, and power industries, as this city is in a highly industrialized area. Headquarters of the meeting will be the Daniel Boone Hotel.

The address of welcome at the general session will be given by Governor William C. Marland of West Virginia. The keynote address will be presented by Miss Vivien Kellems, president of the Kellems Company, who is known for her stand against the withholding income-tax law. AIEE Vice-President W. B. Morton will present the District Prize Paper Awards.

TECHNICAL SESSIONS

There are 15 technical sessions scheduled and two sessions devoted to management problems, with emphasis on hiring and training the young engineer for management responsibilities. These sessions should be valuable as sooner or later the electrical engineer must share and solve management problems if he is to advance in his profession.

In the area of railway transportation three papers on diesel-electric locomotives will be given. Three sessions on power and one on power distribution and transmission will have papers covering low-voltage current limiting fuses; the high-voltage transmission-generation system which is a description of the Appalachian System; 330-kv relaying; transmitters and receivers for power-line carrier; an a-c network calculator and how the utility engineer can employ it; and so forth. Three papers will be given on the protection of cables and in the mining sessions papers on motors, transformers, mine hoist drives, conversion apparatus and its operation, a mine locomotive, and others should prove of interest to engineers in that field.

Monday, September 28, at 9:30 a.m., the Middle Eastern District Executive Committee will convene for the annual business session. This meeting will be held at the Daniel Boone Hotel. This group will be served luncheon at 12:15, with the meeting reconvening at 1:30 p.m. Walter B. Morton, Vice-President District 2, will preside.

For members who plan to enjoy some of the scenic beauty of West Virginia, and thus arrive early in Charleston, a Hospitality Room will be provided at the Daniel Boone Hotel. This room will be open Sunday evening, September 27. Local AIEE members will be on hand to welcome the early arrivals. As a further service to those arriving early, the Registration Desk will open at 8:30 a.m., Monday morning, in the Lobby of the Daniel Boone Hotel.

INSPECTION TRIPS

Several inspection trips have been planned during the meeting in order to show a cross section of the local industry. All members are urged to make one or more of these trips a part of their agenda at the meeting. Please make advance reservations in order that adequate transportation can be provided.

1. Owens-Illinois Glass Company, Charleston, W. Va. (Tuesday afternoon, September 29, 1953, 2:15–4:30 p.m.). This is one of the largest continuous production bottle plants in the United States. Here the dies, glassware, and cartons for many varieties of liquor, food, and soft drink products are made in a modern, automatic operation. Seven furnaces, operating 24 hours per day, make this plant a tremendous producer of bottle glasswares.

Aerial view of Charleston, W. Va., where the AIEE Middle Eastern District Meeting will be held September 29–October 1

Future AIEE Meetings

Pacific General Meeting
Hotel Vancouver, Vancouver, British Columbia, Canada
September 1–4, 1953
(*Final date for submitting papers—closed*)

Middle Eastern District Meeting
Daniel Boone Hotel, Charleston, W. Va.
September 29–October 1, 1953
(*Final date for submitting papers—closed*)

Aircraft Electric Equipment Conference
Benjamin Franklin Hotel, Seattle, Wash.
September 30–October 2, 1953

Conference on the Application of Motors to Air-Moving Equipment and Symposium on Induction Motors
Hotel Van Orman, Fort Wayne, Ind.
October 6–8, 1953

Conference on Machine Tools
Cleveland Hotel, Cleveland, Ohio
October 14–16, 1953

Textile Industry Conference on Electric Equipment
North Carolina State College, Riddick Laboratories Auditorium, Raleigh, N. C.
October 29–30, 1953

Fall General Meeting
Muehlebach Hotel, Kansas City, Mo.
November 2–6, 1953
(*Final date for submitting papers—closed*)

AIEE-IRE Conference on Electronic Instrumentation in Nucleonics and Medicine
New Yorker Hotel, New York, N. Y.
November 18–20, 1953
(*Final date for submitting papers—closed*)

AIEE-IRE-ACM Eastern Computer Conference
Statler Hotel, Washington, D. C.
December 8–10, 1953
(*Final date for submitting papers—September 9*)

Winter General Meeting
Statler Hotel, New York, N. Y.
January 18–22, 1954
(*Final date for submitting papers—October 20*)

Conference on Feedback Control
Claridge Hotel, Atlantic City, N. J.
April 22–23, 1954
(*Final date for submitting papers—January 25*)

Summer and Pacific General Meeting
Los Angeles, Calif.
June 21–25, 1954
(*Final date for submitting papers—March 23*)

2. *True Temper Corporation, Kelly Works, Charleston, W. Va.* (Wednesday morning, September 30, 1953, 10:00–12:00 noon). The Kelly Works is the largest axe and hoe factory in the world. Here, finished axes, hoes, hammers, and numerous other small tools are made.

3. *Kanawha Plant of the Appalachian Electric Power Company, Glasgow, W. Va.* (Wednesday afternoon, September 30, 1953, 2:00–4:30 p.m.). This is the latest and most modern in the Appalachian System, having a capacity of two 200,000-kw units. This plant is the eastern terminus of the new 330-kv transmission system being inaugurated by the American Gas and Electric Company, Appalachian's parent company. Many new engineering features are incorporated in this plant, including a center-fed high-pressure turbine, operating at initial steam pressure of 2,100 pounds per square inch and 1,050 degrees Fahrenheit.

4. *Cannelton Coal and Coke Company, Cannelton, W. Va.* (Thursday morning, October 1, 1953, 9:00–12:00 noon). This coal preparation plant is the newest in the Kanawha Valley area, and incorporates the latest in control facilities. It has a capacity of 450 tons per hour of mine run coal, and also is equipped with rock-handling facilities. The unit incorporates fluid coupling on the main belt conveyor drives and the latest in push-button panel control. This preparation plant utilizes 1,060 horsepower in connected load to handle the necessary equipment.

5. *USS LSSL-65 Land Ship Supply.* (Thursday afternoon, October 1, 1953, 2:00 p.m.). The United States Navy, Fifth Naval District, will provide the USS *LSSL-65* for an inspection trip and cruise. Visitors will be afforded an opportunity to see the Navy in operation, as well as a "fish-eye" view of some of the local chemical industry. If time permits, the ship will pass through the Marmet Locks. This ship will handle a large group and there will be no charge for the cruise. Be sure to make reservations early.

ENTERTAINMENT

Tuesday, September 29, at 12:15 p.m., there will be a General Meeting Luncheon. This luncheon will be open to all members, wives, and guests. Honorable John T. Copenhaver will give a brief message of welcome. C. W. Schweers, vice-president and director of sales, Allis-Chalmers Manufacturing Company, Milwaukee, Wis., will have an interesting message. At 6:30 p.m., a "Guys and Gals Party" at the Shrine Mosque (opposite the Daniel Boone Hotel) will be held. Dinner will be followed by a show, featuring several acts. All members, wives, and guests are welcome. Dress is informal.

On Wednesday, September 30, at 12:15 p.m., will be a luncheon with Hubert Kelly, president, Kanawha County Court, presiding. The AIEE Ohio Valley Section will sponsor this luncheon, which is open to all members, wives, and guests, and will present a short, interesting, nontechnical program. That evening at 5:45 p.m. a Cocktail Party and Banquet will be held. Following the dinner, through the courtesy of General Motors, Dr. John O. Christianson, of the University of Minnesota, will have a very entertaining presentation. Open to members, ladies, and guests. Dress is informal.

The new 400,000-kw Kanawha River Plant of the Appalachian Electric Power Company, now under construction at Glasgow, W. Va., may be inspected by members attending the Middle Eastern District Meeting

On Thursday, October 1, 12:15 p.m., at a luncheon Roy Bird Cook, West Virginia historian, will give "the undercover story" of the Magic Valley and the Mountain State. Open to members, wives, and guests.

LADIES' PROGRAM

Each morning the Sun Parlor will be open for the ladies, where they can get acquainted and be served coffee and rolls. It will be open Tuesday 8:30–9:30 a.m.; Wednesday and Thursday from 10:00–11:30 a.m. A visit to the West Virginia State Capitol, and tea, has been arranged for Tuesday, September 29, at 2:00 p.m. Governor William C. Marland will welcome the ladies in his office and arrange for a tour of the Capitol. After the tour, tea will be served. Miss Vivien Kellems will be present. Transportation will be provided to and from the Capitol. No charge.

On Wednesday, September 30, 1953, at 2:00 p.m. there will be a cruise on the USS *LSSL-65* on the Kanawha River which will afford a beautiful view of the State Buildings, Morris Harvey College, and other points of interest. Refreshments will be served. Low heel shoes required. Please make reservations early. Although this is primarily for the ladies, men are welcome.

ELECTROTHERMAL COMMITTEE

The Electrothermal Committee has selected this District meeting as the location of their annual meeting. Morning and/or afternoon sessions will be held on Wednesday, as the committee desires. Earl Browning will preside at the committee meetings and technical sessions.

MINING SUBCOMMITTEE

The Mining Subcommittee plans to hold their annual meeting, but plans for the executive sessions are incomplete; however, arrangements have been made for this committee to hold sessions Wednesday morning, September 30. R. B. Moore, chairman, will be in charge of this meeting.

HOTEL RESERVATIONS

Rooms have been set aside at the Daniel Boone Hotel (meeting headquarters) and other nearby hotels for members and guests attending. Requests for reservations should be mailed prior to September 15 to the American Institute of Electrical Engineers, Box 406, Charleston 22, W. Va. It may be necessary for the Hotel Committee to transfer some reservations to one of the other hotels on the list.

Accommodations have been reserved at the following hotels:

Daniel Boone Hotel (Meeting headquarters), Washington and Capitol Streets

Single Room	$ 5.00 and up.
2 Person—Double	7.00 and up.
2 Person—Twin	7.50 and up.

Ruffner Hotel, Kanawha Boulevard and Hale Street

Single Room	$ 3.50 and up.
2 Person—Double	5.50 and up.
2 Person—Twin	7.00 and up.

Kanawha Hotel, Summers and Virginia Streets

Single Room	$ 4.00 and up.
2 Person—Double	6.00 and up.
2 Person—Twin	7.50 and up.

Graystone Hotel, 2630 Kanawha Boulevard

Single Room	$ 6.00 and up.
2 Person—Double	9.00 and up.
2 Person—Twin	10.00 and up.

Holley Hotel, 1008 Quarrier Street

Single Room	$ 5.00 and up.
2 Person—Double	7.00 and up.
2 Person—Twin	7.00 and up.

REGISTRATION

The registration facilities will be open at 8:30 a.m., Monday morning, September 28, and will remain open daily through Thursday noon, October 1, 1953.

Those who receive an advance registration card should fill it in and return it promptly. Arrangements have been made to expedite the registration for those who register in advance, and promptly return the cards.

MIDDLE EASTERN DISTRICT MEETING COMMITTEE

Members of the 1953 Middle Eastern District Meeting Committee are: R. H. Greame, chairman; H. K. Atkins, secretary; R. H. Hively, administration and co-ordination; F. A. Leinberger, treasurer; C. R. Stouch, arrangements; G. W. Unangst, technical program; W. J. Hess, publicity; P. M. Barlow, meetings and inspection trips; E. D. Knight, finance; Mr. and Mrs. C. B. Talley, entertainment; H. L. Lindsey, advisory.

Tentative Technical Program

Middle Eastern District Meeting, Charleston, September 29–October 1

Tuesday, September 29

9:45 a.m. General Session

John C. Fox, honorary chairman, presiding. Address of Welcome. Honorable William C. Marland, Governor, State of West Virginia

Address: "Toil, Taxes and Trouble." Vivien Kellems, president, Kellems Company

Presentation of District Prize Paper Awards. Walter B. Morton, Vice-President, AIEE

2:15 p.m. Mining

R. B. Moore, presiding

53-358. Technical Aspects of Application of Electric Equipment in Coal Preparation Plants. *W. R. Morton*, General Electric Company

53-359. The Effect of Reactive Components in the Measurement of Grounding Circuits. *L. H. Harrison*, United States Bureau of Mines

DP. What Overcurrent Settings for D-C Mining Feeder Circuit Breakers?** *D. J. Baker*, I-T-E Circuit Breaker Company; *C. L. Brown*, United States Bureau of Mines

53-360. Characteristic Power Requirements for Performing Various Functions in Underground Coal Mines. *H. P. Musser*, West Virginia Engineering Company

2:15 p.m. Railway Transportation

L. W. Birch, presiding

DP. Operations of Substations for Heavy Duty Tractions.** *J. C. Fox*, Virginian Railway Company

53-361. Wanted—A Modern Diesel-Electric Rail Car. *K. O. Anderson*, General Electric Company

53-362. Split-Pole Exciters—Their Design and Application on Diesel-Electric Locomotives. *H. R. Stiger*, General Electric Company

DP. Comparison of Gas Turbine, Steam, Diesel-Electric, and Electric Locomotives.** *R. J. Cousins*, Norfolk and Western Railway

2:15 p.m. Power

R. D. Brown, presiding

DP. Interconnecting the Industrial Generating Plant With the Public Utility.** *G. E. Grosser*, Westinghouse Electric Corporation

DP. Development and Application of Power Center Transformers.** *H. S. Gates*, Westinghouse Electric Corporation

DP. A Quick Break Interrupter Switch.** *S. C. Killian, M. Stene*, H. K. Porter Company

DP. Performance Characteristics and History of Low-Voltage Current Limiting Fuses.** *P. C. Jacobs, Jr.*, Chase-Shawmut Company

2:15 p.m. Cable Protection

T. R. Weichel, presiding

DP. Protection of Underground Cable Sheath.** *R. F. Norwood*, The Chesapeake and Potomac Telephone Company of West Virginia

DP. Underground Corrosion.** *W. J. Kretschmer*, Columbia Gas System Service Corporation; *G. F. Orr*, United Fuel Gas Company

DP. Accelerated Aging Studies on Polyethylene for Cable Sheaths.** *B. S. Biggs*, Bell Telephone Laboratories, Inc.

Wednesday, September 30

9:30 a.m. Management Development

E. C. Jones, presiding

DP. Training Engineers for Management.** *R. B. Fetter*, Indiana University

DP. Selling Your Company to the Colleges.** *F. G. Lippert*, American Gas and Electric Corporation

**DP: District paper; no advance copies are available; not intended for publication in *Transactions*.

—PAMPHLET reproductions of authors' manuscripts of the numbered papers listed in the program may be obtained from AIEE Order Department, 33 West 39th Street, New York 18, N. Y., as noted in the following paragraphs.

—PRICES of papers, irrespective of length, are 30 cents to members (60 cents to nonmembers) whether ordered by mail or purchased at the meeting. Mail orders are advisable, particularly from out-of-town members, as an adequate supply of each paper at the meeting cannot be assured. Only numbered papers are available in pamphlet form.

—COUPON books in nine-dollar denominations are available for those who may wish this convenient form of remittance.

—THE PAPERS regularly approved by the Technical Operations Committee ultimately will be published in the bimonthly publications and Transactions; also, each is scheduled to be published in Electrical Engineering in digest or other form.

9:30 a.m. Power

G. E. Hervey, presiding

DP. A-C Network Calculator and Its Use by the Utility Engineer.** *L. L. Fountain*, Westinghouse Electric Corporation

DP. Recent Developments in Powerhouse Motors.** *M. R. Lory*, Westinghouse Electric Corporation

DP. Voltage Regulation on Electric Distribution Systems in Residential Areas.** *Paul Reimar*, Cincinnati Gas and Electric Company

DP. Application of Regulators.** *H. E. Lokay*, Westinghouse Electric Corporation

9:30 a.m. Mining

R. B. Moore, presiding

DP. Power Supplies for Continuous Mining Machines and Associated Equipment.** *R. M. Hunter*, Rochester and Pittsburgh Coal Company

DP. Performance of the Synchronous Motor—Eddy Current Coupling Drive for the Slope Belt Conveyor Lifting Coal 868 Feet at Orient Mine #3.** *R. R. Richart*, Chicago, Wilmington, and Franklin Coal Company

DP. Mining Transformers—Their Design and Application.** *R. L. Schwab*, Westinghouse Electric Corporation

DP. Electric Braking for A-C Mine Hoist Drive.** *A. H. Huelsman*, General Electric Company

9:30 a.m. Electrothermal

Earl Browning, presiding

DP. A New-Type Arc Furnace Circuit Breaker.** *J. H. Schromeck*, Westinghouse Electric Corporation

DP. High-Current Short-Circuiting Switch for Electrochemical and Electrothermal Applications.** *H. W. Graybill*, R. and I. E. Company

DP. Electrothermic Reduction of Ores.** *H. S. Newhall*, Pittsburgh Lectromelt Furnace Corporation

2:00 p.m. Mining

C. O. Wood, presiding

53-365. A Low-Height 15-Ton Mine Locomotive for Low Vein Haulage. *J. W. Brauns*, General Electric Company

DP. Conversion Substation Location and Equipment.** *J. A. Dunn*, Island Creek Coal Company

DP. Parallel Operation of Conversion Apparatus.** *L. W. Scott*, General Electric Company

DP. Mine-Type Selenium Rectifiers.** *Herbert Lewis*, Lewis Electrical Manufacturing Company

2:00 p.m. Equipment Application in Chemical and Petroleum Industry

G. O. Wardrop, presiding

DP. Application of Motors in Petroleum and Chemical Industries.** *E. F. Greiwe*, Allis-Chalmers Manufacturing Company

DP. Application of A-C Controls for the Petroleum and Chemical Industries.** *Lewis Daughtrey, Jr.*, Rowan Controller Company

DP. Switchgear for Application in the Chemical Industry.** *Warren Birgel*, Allis-Chalmers Manufacturing Company

2:00 p.m. Power Distribution and Applications

E. L. Munday, presiding

52-72. 240/416-Volt 3-Phase 4-Wire Power and Lighting Supply for Modern Industrial Plants. *William Shuler*, The Dayton Power and Light Company

DP. System Neutral Grounding.** *L. J. Carpenter*, General Electric Company

DP. Modernization of Industrial Plants.** *W. R. Crites*, General Electric Company

DP. Dielectric Heating Applications for Sand Core Drying.** *Carl Loper*, Allis-Chalmers Manufacturing Company

Thursday, October 1

9:30 a.m. Management

Edward Knight, presiding

DP. No Couches—Just Chairs.** *E. J. Ryan*, E. I. du Pont de Nemours and Company

DP. Selection and Training of Key Men in a Large Industrial Organization.** *J. B. Parks*, Westinghouse Electric Corporation

9:30 a.m. Chemical

J. Z. Linsenmeyer, presiding

DP. Electric Heat in the Chemical Industry.** *W. S. Eyth*, Edwin L. Wiegand Company

DP. Cost of Purchased Power Versus Generated Power in Chemical Plants.** *H. C. Bauman*, Chemical Construction Corporation

DP. Application of Rectifiers in the Chemical Industry.** *W. E. Gutzwiller*, Allis-Chalmers Manufacturing Company

2:00 p.m. Mining

L. H. Harrison, presiding

53-366. A Track-Laying Shuttle Car. *J. W. Brauns*, General Electric Company

DP. A Continuous Miner.** *J. W. Heimaster*, Carbide and Carbon Chemicals Company

DP. Recent Development in 2-Motor A-C Mine Hoist Control.** *A. H. Myles*, Electric Controller and Manufacturing Company

DP. Use and Application of Neoprene-Sheathed Cables in Mines.** *Thomas Weichel*, Okonite Company

DP.** **Mine Trailing Cables, Construction and Maintenance.** *Steve Bunish*, Anaconda Wire and Cable Company

2:00 p.m. Power

J. E. Housley, presiding

DP.** **System Operation High-Voltage Transmission—Generation System of the Appalachian System.** *H. E. McCormack*, Appalachian Electric Power Company

DP.** **Modern Transmitters and Receivers for Power-Line Carrier.** *J. B. Singel*, Westinghouse Electric Corporation

DP.** **Detecting and Melting Ice or Sleet on Lines.** *H. E. McCormack* (presented by J. W. Kepner), Appalachian Electric Power Company

DP.** **330-Kv Relaying.** *E. W. Woody*, Appalachian Electric Power Company; *H. C. Barnes*, American Gas and Electric Service Corporation

2:00 p.m. Chemical

J. Vodar, Jr., presiding

DP.** **Magnetic Amplifiers in Metering Direct Current on Electrolytic Cell Lines.** *Elwood Downing*, Columbia Southern Chemical Corporation

DP.** **Application of Large Turbine Generators in Chemical Industry.** *J. S. Williams*, Westinghouse Electric Corporation

DP.** **Switchgear Maintenance.** *H. B. Wortman*, Westinghouse Electric Corporation

2:00 p.m. General Industry Applications

Jack Steelman, Jr., presiding

DP.** **Neoprene, the Versatile Rubber.** *P. P. Murawski*, E. I. du Pont de Nemours and Company

DP.** **Audio Fault Finder for Cable.** *G. H. Knapp*, Civil Aeronautic Administration

DP.** **Electricity Applied to Glass Melting.** *J. H. Glaser*, Dunbar Glass Company

Aircraft Electric Equipment Subject of Discussion at Seattle Conference

The AIEE Aircraft Electric Equipment Conference will be held in Seattle, Wash., September 30 to October 2 at the Benjamin Franklin Hotel. Eight technical sessions are scheduled and three inspection trips are planned so that members who go on them will not miss any of the sessions.

The technical and conference papers which will be presented reflect the problems confronting electrical engineers in the aircraft field today. These will include the operation, testing, and measurements of aircraft a-c power systems; the effects of a-c power characteristics in airplanes on the design of electronic equipment; new developments in fuel quantity gauging; reliability of electrical components, and so forth. In short, about 35 papers will be given by engineers active in designing or building airplanes or who are concerned with supplying equipment to companies in which they are built. Their problems are mutual and these sessions will provide a means toward a better understanding of all concerned.

On Tuesday, the day before the conference opens, the AIEE Aircraft Electrical Rotating Machinery and the Altitude Rating of Electric Apparatus Subcommittees have invited any engineers interested to their meetings, the first session of which will be held at 9:00 a.m. and the second at 1:30 p.m. The purpose of these open meetings is to discuss recommendations for items to be included in a standard on the subject of aircraft a-c and d-c generator characteristics. Characteristics involved were suggested by engineers of the airframe manufacturers who are welcome at these sessions to comment on recommendations and suggest further work. These meetings will be at the Benjamin Franklin Hotel, conference headquarters.

INSPECTION TRIPS

1. Boeing Airplane Company (Thursday, Oct. 1). Chartered busses will leave the hotel at noon for Boeing's Seattle plant. Luncheon will be served at the company's cafeteria, followed by an inspection of the plant. Boeing builds *C-97* Stratofreighters, *B-52* Stratofortresses, and *BOMARC* guided missiles in this plant which employs 33,000.

Boeing has acres of research laboratories where complete airplane electric systems are mocked-up, a recently completed supersonic wind tunnel, and a new engineering building. Under construction is a cantilever *B-52* hangar having a 780-foot unobstructed doorway. Transportation cost is 50¢.

2. Snoqualmie Falls Power Plant (Friday, Oct. 2). Glass-topped busses will leave the hotel at 5 p.m. for Snoqualmie Falls, where the river has cut through solid rock to form falls 270 feet high. At 6:30, dinner will be served at Snoqualmie Falls Lodge and at 8 p.m. visitors will tour Puget Sound Power and Light Company's 22,000-kw hydroelectric plant, the only large completely underground powerhouse. Transportation costs $5.00.

3. Destroyer Trip to Neptune Base (Saturday, Oct. 3). At 8 a.m. a United State Navy destroyer-escort will call at United States Naval Receiving Station, Pier 91, for the 2 1/2-hour trip through Puget Sound to Oak Harbor, Whidbey Island. Visitors then will take a bus to Ault Field, Naval Air Station, for tour of the Neptune patrol plane base.

Luncheon will be served in the Commissioned Officers' Mess at Ault Field at 12:30 and at 1:30 p.m. visitors will return by bus to Oak Harbor for a tour of the seaplane base and inspection of mobile units used for training Neptune pilots and crews.

At 2:30 p.m. demonstration of air-sea rescue procedures by helicopter pickup from open water will be held. The destroyer-escort will leave at 3:00 p.m. for return cruise to Seattle, arriving at 5:30 p.m.

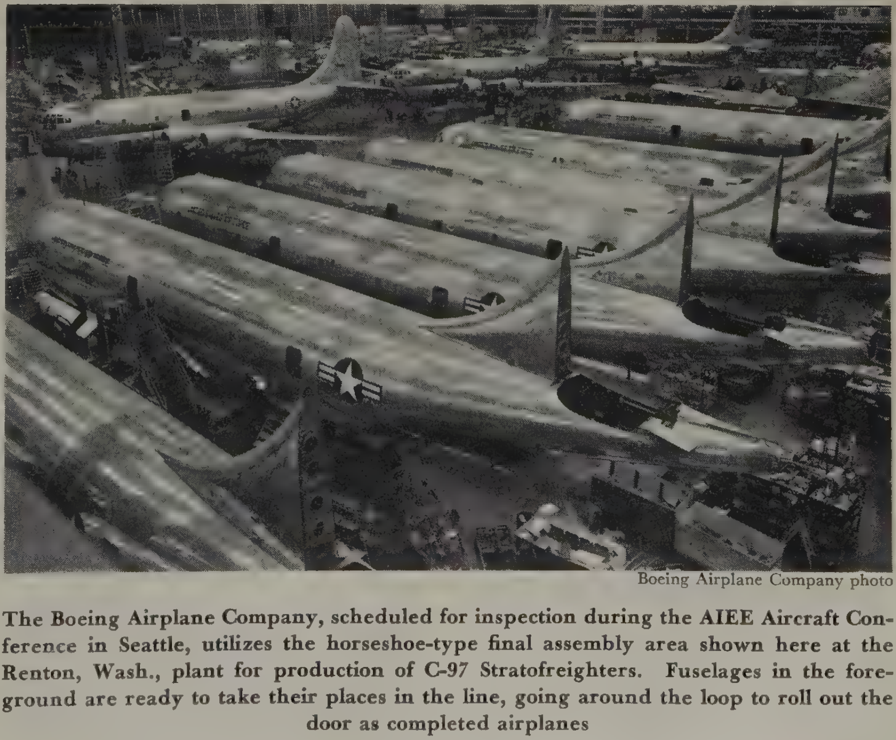
Ladies will be welcome on this cruise and inspection trip. Since only a limited number of persons can be handled, priority will be given to out-of-town engineers who send early registrations. Transportation from hotel to Pier 91 by chartered bus and luncheon will cost $1.50.

RECREATION OPPORTUNITIES

Seattle is in the heart of the International Playground and engineers desiring to combine a vacation with the conference will find many places to visit and things to do: trips to the snow-capped Olympics and Cascades; sailing on Lake Washington, in the heart of Seattle; salmon fishing on Puget Sound; mountain climbing; golf; cruises to the San Juan Islands. A visit to Victoria, Vancouver, and all of British Columbia will pay dividends for this part of Canada is noted for fine hospitality, excellent food, and good accomodations. The Conference Committee will gladly furnish information and assistance.

BANQUET

On Wednesday evening there will be a banquet for engineers and their ladies. The



Boeing Airplane Company photo

The Boeing Airplane Company, scheduled for inspection during the AIEE Aircraft Conference in Seattle, utilizes the horseshoe-type final assembly area shown here at the Renton, Wash., plant for production of C-97 Stratofreighters. Fuselages in the foreground are ready to take their places in the line, going around the loop to roll out the door as completed airplanes

Seattle, with its great vacation possibilities, will be host to the AIEE Aircraft Electric Equipment Conference, September 30–October 2, 1953. Shown here is the famous Lake Washington floating bridge

toastmaster and guest speaker will be announced later.

LADIES PROGRAM

On Wednesday afternoon, September 30, a "Get Acquainted" tea will be held. The banquet is scheduled for Wednesday evening. On Thursday there will be a luncheon and tour of Seattle with visit to the new Childrens' Orthopedic Hospital. On Thursday evening a theatre party will be given at University of Washington's "Penthouse," which has its stage in the center with three rows of seats surrounding it. Friday will be occupied with a walking tour and visits to stores and the waterfront with luncheon at "Ivars." On Friday evening dinner will be served at Snoqualmie Falls. (See Inspection Trips.) On Saturday there will be a destroyer trip to Whidbey Island, a joint activity with the men.

TRANSPORTATION

From the East: Northwest Airlines Super Constellation *Northwest Express* leaves Chicago 7:40 p.m. A later *DC-6* United Airliner leaves New York at 6:00 p.m. (Phone Mr. Flynn or Miss Pollett at MUrray Hill 2-7300.)

From the South: United Air Lines *DC-6I* leaves Los Angeles at 5:00 p.m., arriving a Seattle at 9:00 p.m. Western Airlines has a scenic daylight flight from Los Angeles a 7:40 a.m.

PROCEEDINGS

It is planned to publish under one cover al the papers presented at the conference as well as the discussions of these papers from the floor. This publication will be priced at a cost to be announced later.

HEADQUARTERS HOTEL

The conference headquarters will be the Hotel Benjamin Franklin, Fifth and Virginia Streets, Seattle. Room prices at the hote are as follows:

Single room (single occupancy)	$ 7.0
(double occupancy)	$ 9.0
Twin bedroom	$10.5

COMMITTEE CHAIRMEN

General chairman of the conference i Thomas J. Martin and Ben F. Hager is co chairman. Heading the other committee are D. W. Exner, Papers; R. J. Helberg Banquet; Henry Oman, Publicity; F. L Strum, Finance; J. L. Converse, Inspectio Trips; J. M. Nelson, Hotel Arrangements D. C. Betts, Exhibits; T. C. Bayerd, Regis tration; C. V. Olshan, Hotel Reservations W. A. Burnett, Transportation; R. A. Hen ning, Publications; and Mrs. D. W. Exner Ladies Entertainment.

Tentative Technical Program

AIEE Aircraft Electric Equipment Conference

September 30–October 2

Wednesday, September 30

9:00 a.m. Session 1

CP. Development of an Air-Borne Stabilized Camera Mount.** *J. H. Miller, A. J. Alexander*, Goodyear Aircraft Corporation

53-368.* Use of an Analogue Computer to Optimize the Transient Response of an Aircraft-Type Generator-Regulator System. *H. B. James*, Westinghouse Electric Corporation

CP. Transmission Dynamometer for the Measurement of Transient and Steady-State Torque in Rotating Shafts.** *R. H. Johnson, I. V. Garrison*, Consolidated Vultee Aircraft Corporation, Fort Worth Division.

2:00 p.m. Session 2

CP. Performance of a Constant-Speed Drive.** *E. W. Giloy*, Glenn L. Martin Company

53-369.* New Developments in Differential-Type Hydraulic Transmissions and Controls. *Robert H. Eisengrein*, Sundstrand Machine Tool Company

CP. Considerations Applicable to Automatic Paralleling of A-C Generators.** *M. J. Powell, E. W. Giloy*, Glenn L. Martin Company

CP. Operation of a Static Converter in Parallel With Generators.** *E. W. Colehower*, Glenn L. Martin Company

CP. Effects of Power Arcs on Plastics.** A sound film, Boeing Airplane Company

* Number denotes AIEE *Transactions* papers. Copies may be purchased at AIEE booth or by mail from AIEE Headquarters, 33 West 39th Street, New York, N. Y., at 30 cents each to AIEE members and 60 cents each to nonmembers.

**CP denotes conference papers intended for presentation only and not available except from authors.

Thursday, October 1

9:00 a.m. Session 3

CP. Altitude Rating of Aircraft A-C Generators.** *Hayes Crapo, T. F. Hardman*, Westinghouse Electric Corporation

CP. Loss-Temperature-Environment Relationships for Aircraft Generators.** *Cecil G. Martin*, Jack and Heintz, Inc.

CP. Cooling of Commercial Aircraft Radio Equipment.** *R. E. Hedges*, Douglas Aircraft Company

CP. Survey of Evaporative and Liquid Coolants for Rotating Electric Machines.** *Val Hambor, Cecil G. Martin*, Jack and Heintz, Inc.

7:30 p.m. Session 4A

CP. Some Present Methods and Concepts of Determining the Electric Power System for an Optimum Airplane.** *R. H. Summerl*, Douglas Aircraft Company

CP. Selection Factors for a Jet Transport Electric System.** *E. P. Buckthal, Edward M. Hayes*, United Air Lines

CP. Components Engineering for Improved Aircraft Reliability.** *M. R. Seldon, G. D. Curtis*, Chance-Vought Division, United Aircraft

CP. Effects of A-C Power Characteristics on Electronic Equipment Design.** *J. W. Cramer, C. T. Anderson*, General Electric Company

7:30 p.m. Session 4B

CP. An Analysis of Speed Governor Failure fo Application of Directional Protection to Aircra Alternators.** *A. K. Hawkes, R. E. Zenner*, Armour R search Foundation

53-371.* Effects of Abnormal Conditions on Aircra Parallel A-C Power Systems. *S. C. Caldwell, A. Wood*, General Electric Company

53-372.* Parallel Operation of Aircraft A-C Gene ators. *Lee R. Larson*, Naval Research Laboratory

53-373.* A Differential Reactive-Current Protectiv Relay. *R. W. Stineman*, Boeing Airplane Company

Friday, October 2

9:00 a.m. Session 5A

53-374.* Methods for Prediction of Steady-State Pe formance for Unbalanced Regulated 3-Phase Gener ators. *B. J. Wilson*, Naval Research Laboratory

CP. Overvoltages in Aircraft Resulting From Su den Current Interruption.** *L. J. Stratton*, Armour R search Foundation

CP. Excitation of Aircraft A-C Generators.** *Fra N. Collamore, J. R. Bodker*, Jack and Heintz, Inc.

CP. Wide-Frequency-Range Regulated Tran former Rectifiers.** *J. L. Fink*, General Electric Co pany

9:00 a.m. Session 5B

CP. Measurement of Film Resistance by Nond structive Methods.** *R. A. Holloway, Dr. T. M. Dah* Lockheed Aircraft Corporation

CP. Evaluation of Designs for Intermittently Heated Surfaces.** *Dr. T. M. Dahm*, Lockheed Aircraft Corporation

CP. New Developments in Aircraft Fuel Quantity Gauging.** *Robert J. Levine*, Aviation Engineering Division, Avien-Knickerbocker, Inc.

53-375.* Continuous Current Capacity of Bundled Cables for Aircraft. *Milton Schach, Loren D. Schroeder*, Naval Research Laboratory

CP. Drives and Facilities for Testing Aircraft Power Systems.** *N. C. Clark*, Lockheed Aircraft Corporation

2:00 p.m. Session 6

CP. Use of Antiskid Brakes on Transport Aircraft.** *R. L. Olson*, Northwest Airlines; *G. W. Yarber*, Hydro-Aire, Inc.

CP. System for Providing Wing Flap Unbalance Protection on Transport Aircraft.** *R. J. Hrbacek*, Northwest Airlines

CP. Maintenance of Aluminum Bus and Terminal Connections on Aircraft.** *W. T. Farrish*, Pan American World Airways

CP. Instability in 28-Volt Generator Systems.** *J. B. Harlin, A. L. Landsberger*, Lockheed Aircraft Corporation

53-376.* Control of Metal Buildup in Minimum Pressure Sensitive Contact Systems. *J. P. Dallas, T. R. Stuelpnagel*, Hughes Aircraft Company

AIEE Board of Directors Meets at Summer Meeting in Atlantic City

A regular meeting of the AIEE Board of Directors was held in the Chalfonte-Haddon Hall, Atlantic City, N. J., on June 18, 1953.

The minutes of the meeting of the Board of Directors held on April 23, 1953, were approved as previously distributed.

BOARD OF EXAMINERS

Recommendations adopted by the Board of Examiners at a meeting on May 21, 1953, were reported and approved. The following actions were taken, upon recommendation of the Board of Examiners: 32 applicants transferred and 13 elected to the grade of Member; 2 Members reinstated; 378 applicants elected to the grade of Associate Member; 18 Associate Members reinstated; 43 applicants elected to the grade of Affiliate; 240 Student members enrolled.

Upon proposals, approved by the Board of Examiners, the Board voted to invite the following Members to be transferred to the grade of Fellow:

Robert E. Poole, vice-president—development, Sandia Corporation, Sandia Base, Albuquerque, N. Mex.

James R. Stover, chief electrical engineer, New York State Electric and Gas Corporation, 62 Henry Street, Binghamton, N. Y.

More information regarding the afore-named individuals appears in *Electrical Engineering* in the new department "AIEE Fellows Elected" (pages 819–20).

FINANCES

Treasurer Walter J. Barrett, who was unable to attend the meeting, submitted a written report for the fiscal year which ended April 30, 1953, and the Board voted to accept this report.

Chairman Purnell of the Finance Committee reported disbursements from general funds as follows: May—$107,338.53; June—$92,870.15. The report was approved.

A comparative statement of income and expenses for the first 8 months of the budget year was presented. It showed that the income to May 31, 1953, was $707,270, or 63.7 per cent of the estimated income for the appropriation year, ending September 30, compared with 60.7 per cent last year. Expenses for the 8 months ended May 31 were $731,424, or 63.8 per cent of the estimated expenses for the appropriation year, compared with 69.8 per cent last year.

Upon recommendation of the Finance Committee, based upon statements received from Engineers Joint Council (EJC), covering the last quarter of 1952 and the first two quarters of 1953, the Board voted that the budget be amended to provide an increase of $2,000 in the appropriation for EJC.

After consideration of the point of origin of travel to the Summer General Meeting on which the allowance made to the District Student Prize winners should be based, the Board voted that the allowance be paid only when a winner actually attends the Summer General Meeting, and that it be computed between the college in which the Student member is registered and the place of the meeting, even though he starts from a point other than the location of the college.

ACTIONS AND APPOINTMENTS

Copies of the annual Report of the Board of Directors were distributed, and the Board voted that the report be approved, and that Messrs. Henline and Hibshman be complimented upon the preparation of a report that had brought many favorable comments.

In accordance with the requirement in Section 38 of the Constitution, the appointment of a Secretary of the Institute was considered. H. H. Henline was reappointed.

The Board voted that the usual traveling expense allowance be paid to all District secretaries, incoming and outgoing, for attending the Conference of Vice-Presidents and District Secretaries, and to the incoming Directors who attend the June Board meeting each year.

Upon recommendation of the Committee on Planning and Co-ordination, the Board authorized the holding of the 1954 Summer and Pacific General Meeting in Los Angeles, Calif., June 21–25; the 1955 Summer General Meeting in Swampscott, Mass., June 27–July 1; the Fall General Meeting in Chicago, Ill., October 3–7, 1955, and October 1–5, 1956, and voted that, as a general principle, all District meetings be held in the spring.

The Sections Committee recommended and the Board approved the establishment of the Susquehanna Section, from the Lancaster-York Subsection of the Maryland Section.

The Board approved the recommendation of the Committee on Technical Operations that Special Technical Conferences, duly authorized by the Committee on Technical Operations, be recognized as regular meetings of the Institute (along with General and District meetings) and hence appropriate forums for the presentation of *Transactions* papers, to be effective beginning on August 1, 1953.

Upon invitation, the Board nominated two candidates for the American Standards Association Medal and a candidate for the Howard Coonley Medal, both awarded by the American Standards Association.

As required by the bylaws of the committees, the Board confirmed appointments by President-elect Robertson of G. E. Moore and E. T. B. Gross as members of the Charles LeGeyt Fortescue Fellowship Committee, and O. S. Hockaday, J. J. Pilliod, and E. W. Seeger as members of the Lamme Medal Committee—each for the 3-year term beginning August 1, 1953; also the appointment of S. S. Attwood, Charles F. Wagner, and P. G. Wallace as members of the Edison Medal Committee for the term of 5 years beginning August 1, 1953, and the appointment of James F. Fairman as chairman of the Edison Medal Committee for the year 1953–54. From its own membership, the Board elected F. R. Benedict, D. D. Ewing, and D. A. Quarles as members of the Edison Medal Committee for the term of 2 years beginning August 1, 1953.

The Board reappointed C. A. Powel to the Volta Scholarship Trustees for a term of 6 years beginning August 1, 1953.

Representatives of the Institute on various organizations were appointed, as listed on pages 844–5.

The Board adopted the following resolution for the observance of the 250th anniversary of the birth of Benjamin Franklin in January 1956:

WHEREAS, Benjamin Franklin was one of the first and greatest of American pioneers in the promotion and communication of knowledge for the benefit of people in all countries, making significant contributions in the fields of pure and applied science, education, medicine, agriculture and the graphic arts, as well as domestic and international public service...

WHEREAS, Benjamin Franklin was a founder of some and a member of many of the world's foremost scientific societies of his day, which now plan jointly with others to honor the 250th Anniversary of his birth (on January 17, 1956) with a week-long celebration dedicated to the furtherance of better understanding among nations through science, the arts and human relations...

AND WHEREAS, the AIEE is the founder society in the United States for the profession of Electrical Engineering and is the largest engineering society in the world...

BE IT THEREFORE RESOLVED that the AIEE in recognition of the 250th Anniversary of the Birth of Benjamin Franklin, will:

(*1*). Encourage its Sections and Branches to hold celebrations by such means as they may consider appropriate to the occasion.

(*2*). Recognize the international significance of this Anniversary by suitable means in its publication, *Electrical Engineering*, which has world-wide circulation.

(*3*). Suitably commemorate the event during the AIEE Winter General Meeting to be held in January 1956.

BE IT FURTHER RESOLVED that this resolution be transmitted to The Franklin Institute.

The following Local Honorary Secretaries, whose terms expired July 31, 1953, were reappointed by the Board: W. L. Simpson, for Brazil; A. P. M. Fleming, for England; Stetfan Tanabe, for Japan; R. D. Neale, for New Zealand; Mohamed Hussain Khalid, for Pakistan; Edy Velander, for Sweden.

An invitation from the International Congress of Engineers (FIANI), Rome, Italy, was received, inviting the AIEE members to attend its meeting on October 8–11, 1953, and requesting that the program be

brought to the attention of the members of the Institute.

ATTENDANCE

Present at the meeting were: *President* D. A. Quarles; *Past President* T. G. LeClair; *Vice-Presidents* W. L. Cassell, W. Scott Hill, M. D. Hooven, Thomas Ingledow, E. S. Lammers, Jr., N. M. Lovell, C. M. Lytle, F. W. Norris, J. C. Strasbourger, W. R. Way; *Directors* F. R. Benedict, R. F. Danner, E. W. Davis, D. D. Ewing, L. F. Hickernell, A. C. Muir, N. C. Pearcy, C. S. Purnell, Elgin B. Robertson, Herbert J. Scholz, Victor Siegfried; *Secretary* H. H. Henline; *Assistant Secretary* N. S. Hibshman. By invitation: *Past President* Comfort A. Adams (part time), *incoming Vice-Presidents* C. P. Almon, Jr., A. S. Anderson, G. D. Floyd, W. B. Morton, George C. Tenney; *incoming Director* E. W. Seeger.

Ninth National Electronics Conference to Meet in Chicago, Ill., September 28–30

The ninth annual National Electronics Conference will convene September 28, 29, and 30, 1953, at the Sherman Hotel, Chicago, Ill. The technical program offers 99 papers covering a broad field of electronic research, development, and industrial application and is supplemented by over 140 exhibits by manufacturers foremost in the electronics field.

On the social side, the conference will sponsor three luncheons featuring prominent speakers, an informal evening banquet, and a full 3-day social program for the ladies. Two evenings will be available for viewing the exhibits or visiting any of the various entertainment spots near the Sherman Hotel

The conference is sponsored by the AIEE Illinois Institute of Technology, Institute o Radio Engineers, Northwestern University and the University of Illinois, with Purdue University, University of Wisconsin, the Radio-Electronics Television Manufacturers Association, and the Society of Motion Picture and Television Engineers participating The president of this year's conference is Dr. J. D. Ryder of the University of Illinois

Advance registration may be made by writing: National Electronics Conferences Inc., Karl Kramer, Executive Secretary, 852 East 83d Street, Chicago 19, Ill.

Tentative Technical Program

National Electronics Conference, Chicago, September 28–30

Monday, September 28

9:45 a.m. Circuits I

Continued Fraction Analysis of Tandem Networks. *D. L. Finn*, Georgia Institute of Technology, Atlanta, Ga.

Parallel-T Discriminator Design Techniques. *Paul T. Stine*, Naval Research Laboratory, Washington, D. C.

Synthesis of Resistance-Capacitance-Ladder Networks for Minimization of Flat Loss. *H. Smead*, Purdue University, Lafayette, Ind.

Synthesis of Constant-Time-Delay Networks. *M. S. Corrington, R. W. Sonnenfeldt*, RCA Victor Division, Camden, N. J.

9:45 a.m. Magnetic Amplifiers

Program prepared in co-operation with the AIEE Magnetic Amplifier Committee

The Application of Transistors to the Control of Magnetic Amplifiers. *G. F. Pittman, Jr.*, Westinghouse Electric Corporation, East Pittsburgh, Pa.

Industrial Applications of Transductors. *R. J. Radus*, Westinghouse Electric Corporation, Pittsburgh, Pa.

Magnetic Frequency Conversion. *L. C. Harriott*, General Electric Company, Schenectady, N. Y.

A Magnetic Amplifier for Temperature Detection and Control. *R. I. Van Nice*, Westinghouse Electric Corporation, Pittsburgh, Pa.

Applying Magnetic Amplifiers. *L. W. Buechler*, Vickers Electric Division, St. Louis, Mo.

9:45 a.m. Audio and Microphonics

The "Vagabond" Wireless Microphone System. *T. W. Phinney*, Shure Brothers, Inc., Chicago, Ill.

Some Engineering Considerations of High-Fidelity Sound Reproduction. *S. A. Caldwell*, RCA Victor Division, Camden, N. J.

A Method of Analyzing the Microphonic Output of a Tube and a Description of the CK 6247. *W. H. Hunter*, Raytheon Manufacturing Company, Newton, Mass.

Audio-Frequency Impulse Noise and Microphonism. *R. J. Wohl, S. Winkler, L. N. Heynick, M. Schnee*, New York Naval Shipyard, Brooklyn, N. Y.

12:30 p.m. Luncheon in the Ballroom

2:30 p.m. Circuits II

Directional Coupling With Transmission Lines. *W. L. Firestone*, Motorola, Inc., Chicago, Ill.

A Broad-Band Hybrid Junction for Very-High Frequency and Ultrahigh Frequency. *R. E. Grantham, J. W. Dorsett, Jr.*, Naval Ordnance Laboratory, White Oak, Silver Spring, Md.

Self-Compensated Multilayer Distributed Constant Delay Lines. *W. S. Carley*, Naval Ordnance Laboratory, White Oak, Silver Spring, Md.

A Transmission-Line Oscillatory Pulse Generator. *M. W. Hellar, Jr., W. G. Holter*, General Electric Company, Schenectady, N. Y.

Multiple Resonance Effects in Oscillators. *W. A. Edson*, Stanford University, Stanford, Calif.

2:30 p.m. Servomechanisms

Some Design Considerations of a Saturating Servomechanism. *P. E. Kendall, J. F. Marquardt*, Cook Research Laboratories, Chicago, Ill.

Switching Errors in an Optimum Relay Servomechanism. *T. M. Stout*, University of Washington, Seattle, Wash.

Transient Power Flow Studies of Elementary Servomechanisms. *J. P. Magnin, J. R. Burnett*, Purdue University, Lafayette, Ind.

The Magnetic Modulator in A-C Servo Corrective Networks. *C. Volz*, Pennsylvania State College, State College, Pa.

Possibilities of a 2-Time-Scale Computing System for Control and Simulation of Dynamic Systems. *H. Ziebolz*, Askania Regulator Company, Chicago, Ill.; *H. M. Paynter*, Massachusetts Institute of Technology, Cambridge, Mass.

2:30 p.m. Ultrasonics

Program prepared in co-operation with the Institute of Radio Engineers (IRE) Professional Group on Ultrasonics

Ultrasonics and Industry. *O. Mattiat*, Clevite-Brush Development Company, Cleveland, Ohio

Ultrasonics and Medicine. *J. F. Herrick*, Mayo Clinic, Rochester, Minn.

A Noncontact Microdisplacement Meter. *H. M. Sharaf*, Laboratory for Electronics, Inc., Boston, Mass.

A Temperature Controlled Ultrasonic Solid Acoustic Delay Line. *E. S. Pennell*, Bell Telephone Laboratories, Murray Hill, N. J.

Characteristics of Ultrasonic Delay Lines Using Quartz and Barium Titanate Ceramic Transducers. *J. E. May*, Bell Telephone Laboratories, Murray Hill, N. J.

2:30 p.m. Materials and Components

Magnetic Shielding Effects. *R. D. Teasdale, A. W. Friend*, Magnetic Metals Company, Camden, N. J.

Ferrites and Their Properties at Radio Frequencies. *R. L. Harvey*, Radio Corporation of America, Princeton N. J.

The Application of High-Frequency Saturable Reactors. *G. H. DeWitz*, C.G.S. Laboratories, Inc., Stamford Conn.

Thermoplastic Insulated Tri-Axial Pulse Cables *M. Tenzer, J. Spergel*, Signal Corps Engineering Laboratories, Fort Monmouth, N. J.

Development of a High-Speed Relay. *A. F. Bischoff* General Electric Company, Schenectady, N. Y.

Tuesday, September 29

9:30 a.m. Filters I

Program prepared in co-operation with the IRE Professional Group on Circuit Theory

An Introduction to Modern Filter Theory. *E. A. Guillemin*, Massachusetts Institute of Technology, Cambridge, Mass.

RC Filter of Novel Design. *J. Linvill*, Bell Telephone Laboratories, Murray Hill, N. J.

Low-Frequency Electromechanical Filters. *S. H. Lapin*, Motorola Inc., Chicago, Ill.

Geometric Aspects of Least Squares Smoothing *A. A. Houser*, Sperry Gyroscope Corporation, Great Neck, Long Island, N. Y.

9:30 a.m. Television I

A Continuous All-Electronic Scanner for 16-Millimeter Color Film. *V. Graziano, K. Schlesinger*, Motorola Inc Chicago, Ill.

A New Television Film Scanner. *F. J. Bingley*, Philco Corporation, Philadelphia, Pa.

Vidicon Film Reproduction Cameras. *H. N. Kozanowski*, RCA Victor Division, Camden, N. J.

Alignment of a Monochrome Television Transmitter for Broadcasting National Television System Committee Color Signals. *J. F. Fisher*, Philco Corporation Philadelphia, Pa.

9:30 a.m. Electron Tubes I

Program prepared in co-operation with AIEE Electronics Committee

Improved Instrument Cathode-Ray Tube Design *K. A. Hoagland, H. Grossbohlin*, Allen B. Du Mont Laboratories, Inc., Passaic, N. J.

Space-Charge Behavior in Backward Space-Harmonic Beam Oscillators. *W. G. Dow*, University of Michigan Ann Arbor, Mich.

A Voltage-Tuned High-Power Microwave Oscillator

E. C. Dench, Raytheon Manufacturing Company, Waltham, Mass.

A Radio-Frequency Amplifier Tube for Air-Borne Communications Receivers. *R. E. Moe*, General Electric Company, Owensboro, Ky.

A High-Power Continuous-Wave Magnetron. *D. E. Nelson*, Radio Corporation of America, Harrison, N. J.

9:30 a.m. Nucleonics

Program prepared in co-operation with AIEE Nucleonics Committee

Electronics for a Synchrocyclotron. *L. Kornblith, Jr.*, The University of Chicago, Chicago, Ill.

Nuclear Counting on the Chicago Synchrocyclotron. *M. Glickman, H. L. Anderson, R. Martin*, The University of Chicago, Chicago, Ill.

A 10-Millimicrosecond Scaler. *J. Fischer, J. Marshall*, The University of Chicago, Chicago, Ill.

Instrumentation for Nucleonics and Attendant Accuracy Problems. *R. H. Delgado*, Nuclear Instrument and Chemical Corporation, Chicago, Ill.

12:30 p.m. Luncheon in the Ballroom

Electronics—Thou Most Admired Disorder! *I. S. Coggeshall*, The Western Union Telegraph Company, New York, N. Y.

2:30 p.m. Filters II

Program prepared in co-operation with the IRE Professional Group on Circuit Theory

The Role of Nonlinear Filters in Electronic Systems. *W. D. White*, Airborne Instrument Laboratories, Mineola, N. Y.

Time Filtering of Impulses. *A. A. Gerlach*, Cook Research Laboratories, Chicago, Ill.

Computational Techniques Which Correlate Steady State and Transient Response of Filters. *E. A. Guillemin*, Massachusetts Institute of Technology, Cambridge, Mass.

Use of Sampling Functions to Design for Transient Response. *W. K. Linvill*, Massachusetts Institute of Technology, Cambridge, Mass.

Potential Analogue Methods of Solving the Approximation Problem of Network Synthesis. *R. E. Scott*, Massachusetts Institute of Technology, Cambridge, Mass.

2:30 p.m. Television II

Transition Effects in Compatible Color Television. *J. B. Chatten, R. C. Moore*, Philco Corporation, Philadelphia, Pa.

Aperture Compensation for Television Pickup Equipment. *R. C. Dennison*, RCA Victor Division, Camden, N. J.

An Automatic Television Overload Elimination Circuit. *C. Masucci, J. R. Peltz, W. B. Whalley*, Sylvania Electric Products, Inc., Bayside, Long Island, N. Y.

2:30 p.m. Electron Tubes II

A Reflex Klystron Designed for Rapid Mechanical Tuning. *R. C. Hergenrother, H. W. Cockrill*, Raytheon Manufacturing Company, Waltham, Mass.

A Medium-Power Developmental Traveling-Wave Tube for Microwave Relay Service at 2,000 Megacycles. *W. W. Siekanowicz*, Radio Corporation of America, Harrison, N. J

Long Line Effect With Pulsed and Frequency-Modulated Magnetrons. *W. M. Hall*, Raytheon Manufacturing Company, Waltham, Mass.

The Influence of Vacuum Tube Component Temperatures on Characteristics and Life. *I. E. Levy*, Raytheon Manufacturing Company, Newton, Mass.

The Transient Conduction of Current in a Hot-Cathode Gas Diode. *J. Schuder*, Purdue University, Lafayette, Ind.

2:30 p.m. Computers

The Design of Computer Circuits to Operate at Extremely High Temperatures. *J. F. Koch, Jr., G. C. Hand, Jr.*, Technitrol Engineering Company, Philadelphia, Pa.

A Data-Handling System for General Instrumentation. *M. E. Frank*, California Institute of Technology, Pasadena, Calif.

The Application of Pulse Position Modulation to Digital Computers. *C. B. Kinne*, Raytheon Manufacturing Company, Waltham, Mass.

Magnetic Core Ring Counter. *S. Guterman, R. D. Kodis*, Raytheon Manufacturing Company, Waltham, Mass.

Criteria for the Selection of Analogue-to-Digital Converters. *G. L. Hollander*, Massachusetts Institute of Technology, Cambridge, Mass.

Wednesday, September 30

9:30 a.m. Network Synthesis

Program prepared in co-operation with the IRE Professional Group on Circuit Theory

Formulation of the Approximation Problem. *N. Balbanian*, Syracuse University, Syracuse, N. Y.

The Role of Conformal Transformations in Network Synthesis. *W. R. LePage*, Syracuse University, Syracuse, N. Y.

The Role of Analytic Continuation in Network Synthesis. *S. Seely*, Syracuse University, Syracuse, N. Y.

Synthesis of Resistance-Capacitance Shunted High-Pass Networks. *C. F. White*, Naval Research Laboratory, Washington, D. C.

9:30 a.m. Transistors

Transistor Amplifiers Applied to Delay Lines. *A. H. Schooley*, Naval Research Laboratory, Washington, D. C.

Automatic Gain Control of Junction Transistor Amplifiers. *F. H. Blecher*, Bell Telephone Laboratories, Murray Hill, N. J.

Transistor Feedback Amplifiers. *S. K. Ghandhi*, General Electric Company, Syracuse, N. Y.

Stability Analysis of a Basic Transistor Switching Circuit. *T. R. Bashkow*, Bell Telephone Laboratories, Inc., Murray Hill, N. J.

An Amplitude-Stabilized Transistor Oscillator. *E. R. Kretzmer*, Bell Telephone Laboratories, Inc., Murray Hill, N. J.

9:30 a.m. Instrumentation I

Millimicrosecond Timer Utilizing a Spiral Sweep Cathode-Ray Oscillograph. *Warren Slie, R. H. Stresau, C. Goode*, Naval Ordnance Laboratory, White Oak, Silver Spring, Md.

A Multi-Exposure Microsecond Photographic System. *L. D. Findley, E. S. Kennedy, J. H. Van Horn*, Midwest Research Institute, Kansas City, Mo.

The Generation of Precisely Known Phase Relationships. *J. M. Looney*, Technology Instrument Corporation, Acton, Mass.

High Input Impedance Metering Circuit Employing Precision Zero Suppression for Extending Input Range. *A. D. Ehrenfried*, Massachusetts Institute of Technology, Cambridge, Mass.

9:30 a.m. Microwaves

A High-Power Microwave Coupler Design. *G. I. Cohn, G. T. Flesher*, Illinois Institute of Technology, Chicago, Ill.

Wideband Waveguide to Coaxial Line Adapters Using Stepped Ridge Transformers. *L. Swern*, Sperry Gyroscope Company, Great Neck, N. Y.

Electromagnetic Propagation Through Waveguides of Curtate-Sector Cross Section. *La Plante, T. J. Higgins*, University of Wisconsin, Madison, Wis.

Determination of the Design Constants of Dielectric and Metal-Plate Ultrahigh-Frequency Lenses by Use of Physical Analogy. *W. B. Swift, T. J. Higgins*, University of Wisconsin, Madison, Wis.

Measurement of Microwave Local Oscillator Noise. *G. C. Dalman, E. Ortiz*, Sperry Gyroscope Company, Great Neck, N. Y.

12:30 p.m. Luncheon in the Ballroom

2:30 p.m. Engineering Management

Program prepared in co-operation with the IRE Professional Group on Engineering Management and the IRE Professional Group on Quality Control

Statistical Methods in Experimental Design Serve the Electronics Industry. *F. Caplan, Jr.*, General Electric Company, Syracuse, N. Y.

Control of Cost of Research and Development Projects. *H. J. Finison*, Armour Research Foundation, Chicago, Ill.

Staff Engineer's Part in Control of Design and Development Costs. *H. G. Purinton*, Bendix Radio Company, Baltimore, Md.

An Engineering Incentive Problem. *H. Goldberg*, National Bureau of Standards, Washington, D. C.

The Engineer and His Customer. *C. A. Maynard*, The Indiana Steel Products Company, Valparaiso, Ind.

2:30 p.m. Instrumentation II

The Scintillation Counter as a Low-Voltage X-Ray Detector. *H. Berger*, General Electric Company, Milwaukee, Wis.

Counter Technique in Interference Analysis. *M. M. Newman, R. C. Schwantes, J. R. Stahmann*, Lightning and Transients Research Institute, Minneapolis, Minn.

Conclusive Voltage Calibration of High-Frequency Signals. *W. K. Volkers*, Millivac Instrument Corporation, Schenectady, N. Y.

The Crystal Constant in Microwave Measurements. *G. T. Flesher*, Illinois Institute of Technology, Chicago, Ill.

Void Detector for Sheet Insulating Materials. *R. E. Anderson*, General Electric Company, Schenectady, N. Y.

2:30 p.m. Communication

Program prepared in co-operation with the AIEE Communication Division Committee

Accuracy and Speed on Short-Wave Teleprinter Services. *J. B. Moore*, RCA Communications, Inc., New York, N. Y.

Transatlantic Telephone Communications. *J. R. Rae*, American Telephone and Telegraph Company, New York, N. Y.

The Application of Wideband Radio-Relay Methods in International Telecommunication Services, Including Transatlantic Television. *W. S. Halstead*, Unitel, Inc., New York, N. Y.

Design of a Commercial Facsimile System. *H. P. Corwith*, Western Union Telegraph Company, New York, N. Y.

AIEE Plans Two Sessions at ISA Conference and Exhibit

The AIEE, as a participating society, will conduct two technical sessions at the Eighth National Instrument Conference and Exhibit of the Instrument Society of America (ISA) in Chicago, Ill., September 21–25, 1953. The sessions are planned for the afternoon of September 23 and the morning of September 24. As is customary, the ISA will provide the AIEE with a booth where persons may obtain copies of papers and other literature of interest to those attending. The booth may be used also as headquarters for AIEE sponsoring committees and members.

Members of the general committee for the AIEE program are A. J. Hornfeck, chairman of the AIEE Subcommittee on ISA Co-operation, Bailey Meter Company, Cleveland, Ohio; J. G. Reid, Jr., chairman of the AIEE Committee on Instruments and Measurements (sponsoring committee), National Bureau of Standards, Washington, D. C.; W. H. Wickham, chairman for local arrangements, Commonwealth Edison Company, Chicago, Ill.; R. W. Jones, chairman of the AIEE Chicago Section, Northwestern University, Chicago, Ill.; and R. S. Gardner, AIEE Headquarters representative.

For details of the AIEE technical program, see August *Electrical Engineering*, page 717.

Tentative Schedule of Sessions Announced for AIEE Fall Meeting

Arrangements are in progress for the program of the Fall General Meeting to be held in Kansas City, Mo., November 2–6, 1953. Headquarters for the meeting will be in the Hotel Muehlebach. A full program of broad general interest which is appropriate for the locality of the meeting will be presented in combination with inspection trips, entertainment, and special activities for the visiting ladies. There is much to see in Kansas City and the coming meeting should be one of great interest, particularly when combined with the sessions being prepared by the technical committees of the Institute.

TECHNICAL SESSIONS

During the 5 days of the meeting, it is expected that 29 technical sessions will be held in four broad divisions of Institute endeavor: communications, science and electronics, industry, and power. In addition, a general session of interest for all Institute members and a session on safety will be held. The tentative schedule of the technical sessions being arranged is as follows:

Monday, November 2

10:00 a.m.	General session
2:00 p.m.	Switchgear Communication switching systems Petroleum Computing devices

Tuesday, November 3

9:30 a.m.	Safety Switchgear Petroleum
2:00 p.m.	Aural broadcasting Industrial Insulated conductors Petroleum

Wednesday, November 4

9:30 a.m.	Television Eastern mining Transmission and distribution
2:00 p.m.	Western mining Transmission and distribution Radio communication systems Electrochemistry

Thursday, November 5

9:30 a.m.	Power generation Science and electronics
2:00 p.m.	Power generation Science and electronics Industrial control System engineering

Friday, November 6

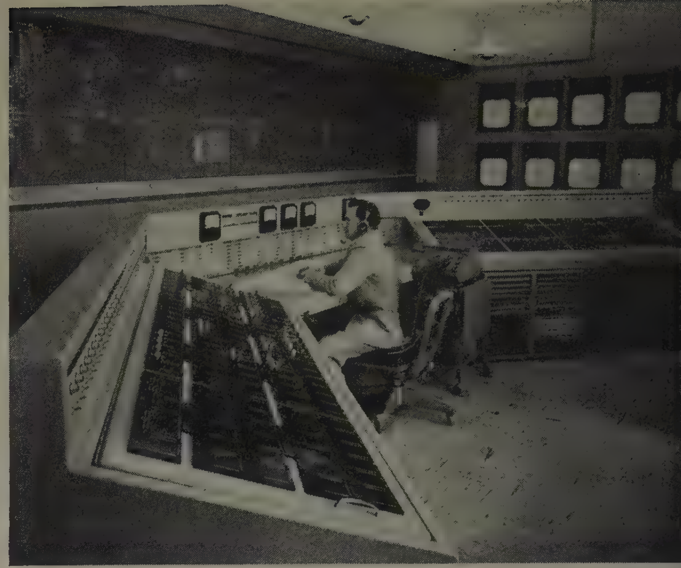
9:30 a.m.	Protective devices and relays System engineering
2:00 p.m.	Rotating machinery Transformers Feedback control systems

INSPECTION TRIPS

Arrangements are being made for the following trips to industries in Kansas City and vicinity. Every effort is being made to emphasize the technical aspects of each trip, but they also should afford the members an opportunity to see the city.

Platte Pipe Line Company has the nation's newest crude oil transportation system. Its 20-inch pipe line extends from Chatham, Wyo., to Woods River, Ill., a distance of 1,056 miles, in which there are 12 pumping stations and 13 valve stations. The operations are controlled from a headquarters in Kansas City with a microwave communications system which provides a means for dispatching, administration, telemetering, and supervisory control of the pumping stations. A trip through the dispatcher's office and microwave station at the top of the Power and Light Building should prove informative as well as interesting.

Scheduled for inspection during the Fall General Meeting is the Platte Pipe Line Company. Here, a dispatcher controls the flow of crude oil over 1,056 miles of pipe line automatically from Kansas City by microwave



Hawthorn Power Plant of Kansas City Power and Light Company is a new steam-electric generating station. It has two 66,000-kw and one 99,000-kw unit. Another 99,000-kw unit is under construction. The unit system design is used and fired with pulverized fuel. Voltage is stepped up to 66,000 and 161,000 at the plant and transmitted via overhead transmission lines.

Station WDAF-TV of the Kansas City Star is located in a new building in which all of the programs, studio, commercial, communication, and operating facilities are assembled in one place. Special attention will be given to the electric equipment and its operation on the inspection trip. The station is rated at 100 kw of visual effective radiated power. It operates between 66 and 72 megacycles on Channel 4. The adjacent tower is 724 feet high.

Sheffield Steel Corporation, one of the largest steel companies in the Midwest, has many features of interest to engineers. Two of these are the new electric arc furnace and the rod and merchant mill. The electric furnace has 100-ton capacity and is rated at 25,000 kva. Approximately 4 hours of continuous operation are required to melt down scrap steel ready to tap. This furnace is one of the largest in the area and has seen service since August 1952.

The General Motors Corporation Plant where Buicks, Oldsmobiles, and Pontiacs are assembled and finished on the same line is an interesting operation scheduled for inspection by the members.

HOTEL ACCOMMODATIONS

It is suggested that members planning to attend should make their hotel reservations early. Requests for hotel rooms should be addressed to Miss Mary Nugent, AIEE Housing Bureau, 1030 Baltimore Avenue, Third Floor, Kansas City 6, Mo. Rooms have been set aside at the following four hotels. The hotel and type of accommodation as well as the rate desired should be specified. Every effort will be made to supply accommodations requested.

The Continental at 11th and Baltimore	$4.50 to $12.00
Hotel Muehlebach at 12th and Baltimore	6.00 to 15.00
The Phillips at 12th and Baltimore	5.00 to 10.50
The President at 14th and Baltimore	5.00 to 13.00

COMMITTEES

The members of the General Committee for the 1953 Fall General Meeting are C. G. Roush, chairman; Riley Woodson, vice-Chairman; S. M. Pollock, secretary-treasurer; C. M. Lytle, Vice-President, District 7; J. C. Bibbs, J. E. Barfield, O. H. Johnson, C. M. Haynes, members-at-large. The subcommittee chairmen are J. P. Kesler, registration and hotel; William Carter, reception; L. M. Schindler, technical program; R. L. Baldwin, finance; A. C. Kirkwood, entertainment; H. E. James, inspection trips; M. J. Horney, publicity; L. L. Davis, transportation; O. L. Starcke, printing; W. P. Smith, students; Mrs. S. H. Pollock, ladies.

Committee on Computing Devices Reports on Recent Activities

In the discharge of its function of promoting fundamental developments in the computer field, providing a medium for the interchange of information on computer developments and application, and in keeping the AIEE membership informed of progress in this field, the AIEE Committee on Computing Devices is now active on a number of projects.

It is a participant with the Institute of Radio Engineers (IRE) and Association for Computing Machinery in the Joint Computer Conference which now is set up on a permanent annual basis. The first conference held in 1952 dealt with electronic digital computers, and the 1953 conference with input-output devices. The next conference

December 8 to 10, 1953, in Washington, D. C., will deal with information-processing devices, their reliability and requirements. Proceedings of these conferences have been published and copies are available from AIEE Headquarters, 33 West 39th Street, New York, N. Y., as follows:

1. Review of Electronic Digital Computers, February 1952. $3.50.

2. Review of Input-Output Equipment used in Computing Systems, March 1953. $4.00.

3. The December 1953 conference proceedings will be published by IRE.

Other committee activities include the following.

A Western Joint Computer Conference is being planned for February 1954 in southern California.

At the Summer General Meeting session on new developments in digital computers in Atlantic City, N. J., four papers were presented dealing with memory devices and analogue-digital converters.

A bibliography committee is active under the direction of Dr. J. W. Mauchly of Remington Rand and has a computer bibliography nearing completion, including short abstracts of each item, which probably will be presented in January 1954.

A subcommittee on digital computer comparisons has been formed under the direction of W. H. MacWilliams, Jr., Bell Telephone Laboratories, Whippany, N. J. Anyone having made comparisons which might be contributed to this effort should contact Dr. MacWilliams.

The other subcommittee chairmen, G. G. Hoberg, Philadelphia, Pa., (digital computers); Dr. G. D. McCann, California Institute of Technology, Pasadena, Calif. (analogue computers); and C. R. Wayne, Syracuse, N. Y., (analogue-digital conversion devices) will be glad to receive suggestions for session topics, papers, or projects in their respective fields.

Technical sessions at the Winter General Meeting will include papers on analogue computer comparisons and new developments in digital and analogue computers. A session is planned also on "Making Digital Computers Useful to Engineers." This will be a study of programming problems, including both simplified programs or computer arrangements particularly adapted to the rapid and convenient programming of the medium-sized problems characteristic of engineering. Technical papers should be submitted by October 20, 1953, for this meeting.

Suggestions or questions regarding the functioning of the committee should be addressed to the chairman, F. J. Maginniss, Analytical Engineering Department, General Electric Company, Schenectady, N. Y.

Lamme Medal Nominations Must Be Submitted by December 1

Members of the Institute again are reminded that they have an opportunity to submit nominations for the 1953 Lamme Medal. All nominations must be received not later than December 1, 1953.

Details regarding qualifications for the award were published in the June 1953 issue of *Electrical Engineering*, page 545.

COMMITTEE ACTIVITIES

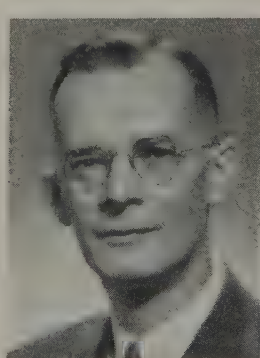
Editor's Note: This department has been created for the convenience of the various AIEE technical committees and will include brief news reports of committee activities. Items for this department, which should be as short as possible, should be forwarded to R. S. Gardner at AIEE Headquarters, 33 West 39th Street, New York 18, N. Y.

Note. Because of the changeover in committee personnel, no items on committee activities are included in this issue.

AIEE FELLOWS ELECTED..

Board of Directors Meeting, April 23, 1953

John W. Baring (M '41), assistant chief testing engineer, Commonwealth Edison Company, Chicago, Ill., has been transferred to the grade of Fellow in the AIEE "in recognition of contributions to fundamental data in the field of power equipment design and operation." Mr. Baring was born in Chicago, Ill., March 28, 1895, and completed 4 years in electrical engineering at Armour Institute of Technology in 1916. The same year, he became associated with the Commonwealth Edison Company's Testing Department. Prior to 1940, Mr. Baring served as tester, testing engineer, and starting engineer. He was directly responsible for the correct operation of the generators and auxiliary electric equipment when put in service, and had responsibility for detecting errors, if any, in the manufacture, engineering, or construction of the electric equipment or its installation. He analyzed cases of trouble, assisted the Construction Department in restoration of service, acted as consultant to the Engineering Department on design problems and to the Operating Department on operation of equipment. Since 1940, he has held the positions of head starting engineer, apparatus engineer, and assistant chief testing engineer. As head starting engineer, he directed the activities of testing engineers in the generating stations, as apparatus engineer, he directed the activities of all testing engineers for the Edison System. As assistant chief testing engineer, the position he has held for the past 5 years, he assists in directing the activities of the testing department. Activities under his direction include testing and certifying for service all electric equipment on the system; the testing and maintenance of protective relays, station instruments, supervisory controls, electronic devices, and carrier current installations; and chemical testing. Mr. Baring is a member of the Western Society of Engineers and is a registered professional engineer in Illinois.

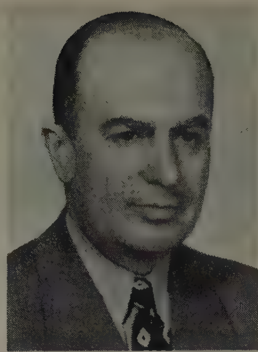


John W. Baring

Herbert H. Cox (AM '08, M '27, Member for Life), assistant engineer of operation, Department of Water and Power, City of Los Angeles, Calif., has been transferred to the grade of Fellow in the AIEE "in recognition of pioneering work in the field of large high-voltage systems." Mr. Cox was born in Danville, Ind., July 15, 1888, and graduated from California Polytechnic School in 1906. From September 1905 Mr. Cox occupied positions in connection with the operation of electric plants in California, both hydroelectric and steam-electric. In May 1913 he was placed in charge of the operation of the 150,000-volt transmission system of the Pacific Light and Power Company. From May 1917 to May 1922 he continued supervision of this transmission line of the Southern California Edison Company, while the first experimental 220,000-volt transmission line was placed in service under his control. On the basis of this experience and with development of the operating techniques, the entire Big Creek system was raised from 150,000 to 220,000 volts. In May 1922 the electric system of the Southern California Edison Company within the City of Los Angeles was purchased by the Department of Water and Power. Mr. Cox was transferred to the department and placed in charge of operating all terminal receiving stations and distributing stations within the city. In 1924 he was named a member of a committee which directed all the early preliminary work in connection with the development program for the power supply from Hoover Dam and the 287,500-volt transmission system for that purpose. In August 1946 Mr. Cox was given responsibility

Herbert H. Cox

Frederick B. Johnson



Robert E. Poole

James Riley Stover

for the construction, operation, and maintenance of the distribution system within the City of Los Angeles. Mr. Cox has been active in the development of safe practices for work on high-voltage underground cables. He is a member of the Pacific Coast Electrical Association and the Electric Club of Los Angeles. He is past chairman of the Los Angeles Section of the AIEE (1921–22).

Frederick B. Johnson (M '37), chief testing engineer, Commonwealth Edison Company, Chicago, Ill., has been transferred to the grade of Fellow in the AIEE "for contribution to the improvement of commutation in rotary converters and to the development of remote control for urban substations." Mr. Johnson was born in Waukon, Iowa, July 26, 1889, and received the electrical engineering degree from Iowa State College in 1910. He joined Commonwealth Edison in 1912 as a tester, later becoming testing engineer, starting engineer, apparatus engineer, assistant chief testing engineer, and at present chief testing engineer. Mr. Johnson has been responsible for certification of electric equipment for use and for installation of the equipment in substations and distributing stations. He certified for installation thousands of kilowatts of capacity for a large district of the system in Chicago. As chief of the testing department, he is responsible for its operation. The activities of the department include testing and certifying for service all electric equipment in generating stations and substations on the system; the testing and maintenance of protective relays, station instruments, supervisory controls, electronic devices, and carrier current installations; and chemical testing. He is a member of the Western Society of Engineers and is a registered professional engineer in the state of Illinois.

Board of Directors Meeting, June 18, 1953

Robert E. Poole (AM '24, M '34), vice-president–development, Sandia Corporation, Albuquerque, N. Mex., has been transferred to the grade of Fellow in the AIEE "in recognition of able administration of scientific and engineering projects, and contributions to the development of radio telephony and television, radar, and atomic weapons." Mr. Poole was born in West Hoboken, N. J., January 17, 1899, and was graduated from Stevens Institute of Technology in 1921. He was an instructor in electrical engineering at Stevens from 1921 to 1924, also serving as an assistant in work on radio receiver design, vacuum tube design, and measurement of soil resistivity in connection with electrolysis surveys. Since 1924 he has been a member of the technical staff of Bell Telephone Laboratories. From 1924 to 1926 he prepared designs and conducted experimental work on circuits of 5- and 50-kw radio broadcast transmitters, having been placed in charge of the engineering staff at the radio development laboratory in Whippany, N. J., in 1924. In 1928 he designed, installed, and operated 50- and 5-kw radio apparatus for a radio television demonstration, and from 1929–1933 supervised the design and construction of a 300-kw long-wave transmitter for use in the transatlantic telephone system. From 1933–1935 he supervised design of all Western Electric radio broadcast transmitting equipment. He was appointed department head in charge of broadcasting and transoceanic division of apparatus development department in 1935 and in 1936 was appointed broadcast development engineer of Bell Laboratories. In 1939 he supervised the first application of radar principles for experimental purposes and subsequently in 1940 developed the first Army fire control mobile radar equipment and in 1941 supervised the development of the first Navy fire control radar. From 1942 to 1947, as a department head, Mr. Poole supervised the development of Navy, Army, and Air Force radar fire control and bombing equipment. He was appointed director of military electronics department of Bell Laboratories in 1948, and in 1949 he was appointed director of research and development, Sandia Laboratory, in charge of ordnance development, design, and application of atomic weapons for the Atomic Energy Commission. He became vice-president–development in 1952. Mr. Poole is also serving as chairman, Special Weapons Development Board. He is a member of the Institute of Radio Engineers and has served on the AIEE Committee on Standards (1949–50) and as a Liaison Representative on Standards (1951–53).

James Riley Stover (AM '26, M '32), chief electrical engineer, New York State Electric and Gas Corporation, Binghampton, has been transferred to the grade of Fellow in the AIEE "for contributions to the electrical development of an electric utility particularly in transmission and distribution." Mr. Stover was born in Boalsburg, Pa., June 1, 1898, and graduated from Pennsylvania State College in 1921 with a bachelor of science degree in electrical engineering. Soon after graduation he became associated with the Pennsylvania Edison Company, Easton, as electrical system operator and load dispatcher. In 1923 he joined Metropolitan Edison Company, Reading, Pa., first as test engineer and later in substation design and construction. From 1926 to 1939 he was with W. S. Barstow and Company (later E. M. Gilbert Engineering Corporation), Reading. During this period Mr. Stover served as electrical engineer on numerous construction and improvement projects, designed a short-circuit slide rule for use on transmission and distribution systems, supervised engineering work in preparing a transmission line standards book, and prepared short-circuit, load, and stability studies and reports. In 1939 he joined New York State Electric and Gas Corporation. Some of the projects under his supervision were installation of step voltage regulators on interconnections, design of underground network systems, preparation of standards, design of a method of extinguishing the arc on a gang-operated outdoor 115-kv air-break switch by high pressure air or gas, and general distribution design studies regarding major changes and additions to the distribution system. Mr. Stover became chief electrical engineer in 1951. He is a member of the New York State Society of Professional Engineers and the Edison Electric Institute and is a registered professional engineer in New York and Pennsylvania.

AIEE PERSONALITIES....

D. A. Quarles (AM '23, F '41), president, Sandia Corporation, Albuquerque, N. Mex., and vice-president, Western Electric Company, Inc., New York, N. Y., has been appointed Assistant Secretary of Defense for Research and Development. Mr. Quarles, who was president of the Institute for 1952–53, was formerly a vice-president of the Bell Telephone Laboratories, Inc., New York. He was born on July 30, 1894, in Van Buren, Ark., and was graduated from Yale University in 1916 with a bachelor of arts degree. During World War I he served with the United States Army for years before he was discharged with the rank of captain. In 1919 he joined the Western Electric Company Engineering Department which, in 1925, became Bell Telephone Laboratories, Inc. From 1919 to 1924 he was in transmission engineering and research and then for 4 years he was a member of the Inspection Engineering Department in charge of apparatus inspection engineering. He was made director of Outside Plant D

D. A. Quarles

I. M. Stein

C. S. Redding

C. E. Smith

velopment in 1929 and was in charge of the study of telephone materials and designs used in the outside plant and the development of new and improved materials and designs. As director of Transmission Development from 1940 to 1944 he was in charge of the development of carrier telephone systems, broad-band telephone and television systems, and improved voice-frequency transmission systems. He was elected a vice-president of the Laboratories in 1947. Mr. Quarles was vice-chairman of the committee on electronics of the Government's Joint Research and Development Board. He is a member of the American Physical Society, the Institute of Radio Engineers, the Yale Engineering Association, the American Association for the Advancement of Science, and the Telephone Pioneers of America. Mr. Quarles also has served the AIEE as a director and on many committees including Finance, Edison Medal, Electronics, Instruments and Measurements, Planning and Co-ordination, Headquarters, Lamme Medal, and Management. The Institute takes pride in this distinguished honor which has been conferred upon Mr. Quarles.

I. M. Stein (AM '18, F '39), executive vice-president, Leeds and Northrup Company, Philadelphia, Pa., has been elected president of the company. Mr. Stein was born in Long Branch, N. J., and received his early scientific education at Edison Technical School and Columbia University. For several years he was associated with New York Edison Laboratories. During World War I he was personal assistant to Thomas A. Edison when the inventor was chairman of the Naval Advisory Board. Mr. Stein joined Leeds and Northrup in 1919 as a salesman. In 1928 he was appointed director of research. He was elected a vice-president in 1944 and in 1951 became executive vice-president. He received a Presidential Certificate of Merit for his work as a section head in the Office of Scientific Research and Development, in which he served during World War II. Mr. Stein is a fellow of the American Association for the Advancement of Science and The American Society of Mechanical Engineers and a member of the American Physical Society, Pennsylvania Society of Professional Engineers, and the Engineers Club of Philadelphia. He is chairman of the museum committee of the Franklin Institute and was formerly chairman of the Engineers Joint Council's Committee on the Economic Status of the Engineer. A former vice-president of the Institute (1937–39), Mr. Stein has served on the following AIEE committees: Membership (1926–27, 1931–33); Sections (1929–41, Chairman, 1933–36); Board of Directors (1937–39); Planning and Co-ordination (1933–44); Publication (1934–42, Chairman, 1936–40); Award of Institute Prizes (1936–40); Technical Program (1936–41); Constitution and Bylaws (1938–46, Chairman, 1941–44); Institute Policy (1938–40); Lamme Medal (1941–44); Science and Electronics Division (1948–53); and Edison Medal (1946–51).

C. S. Redding (AM '12, F '48, Member for Life), president, Leeds and Northrup Company, Philadelphia, Pa., has become chairman of the board. Mr. Redding first became associated with Leeds and Northrup as a draftsman in 1901, but he left the company 15 months later to enter the University of Pennsylvania, where he was graduated in 1907. He rejoined Leeds and Northrup in 1909 as a salesman after teaching 2 years at the university, which honored him with the degree of doctor of science in 1947. He was appointed associate sales manager in 1917 and successively became second vice-president, assistant treasurer, treasurer, factory manager, and vice-president in charge of engineering and development. He was elected president just before World War II. Mr. Redding is a director and past president of the Franklin Institute, Metal Manufacturers Association of Philadelphia, and Scientific Apparatus Makers Association, and a trustee of Drexel Institute of Technology. He is a member of the American Physical Society and the American Association for the Advancement of Science.

C. E. Smith (AM '32, M '38), vice-president in charge of engineering, United Broadcasting Company, Cleveland, Ohio, has resigned from United Broadcasting and will devote full time to consulting engineering work. Mr. Smith's new organization will continue under the name of Carl E. Smith Consulting Radio Engineers. Mr. Smith also continues to serve as president of Cleveland Institute of Radio Electronics. Mr. Smith is a 1930 engineering graduate of Iowa State College. After a year with RCA Victor Company, Camden, N. J., he took postgraduate work at Ohio State University, obtaining a masters degree in 1932 and a professional degree in 1936. He became associated with United Broadcasting at that time. During World War II Mr. Smith was assistant chief, Operational Research Staff, War Department, Washington, D. C., where he was initially in charge of training and later headed the equipment and propagation activities. He is a member of the Institute of Radio Engineers, American Society for Engineering Education, Society of Motion Picture and Television Engineers, and the Cleveland Engineering Society. He is a registered professional engineer in Ohio and Washington, D. C., and has served on the AIEE Committee on Radio Communication Systems (1951–53).

D. I. Bohn (AM '23, F '49), chief electrical engineer, Aluminum Company of America, Pittsburgh, Pa., has asked to be relieved of his duties and responsibilities for reasons of health and accordingly has been reassigned to head special electrical development engineering work. Mr. Bohn was awarded the 1950 AIEE Lamme Medal "for his pioneering development and application of electrical equipment for controlling rectifying systems in the production of aluminum." Mr. Bohn was born November 29, 1896, in Chicago, Ill., and was graduated from the University of Wisconsin in 1921 with the degree of bachelor of science in electrical engineering. For 2 years following his graduation, Mr. Bohn was associated with the General Electric Company. In 1923, he became assistant electrical superintendent, Aluminum Company of America, and was appointed electrical superintendent in 1926, assistant chief electrical engineer in 1928, and chief electrical engineer in 1946. He has written many technical articles and has many patents to his credit. Mr. Bohn has done work in the field of induction heating, electric resistance welding of aluminum, and was in charge of the first large installation of mercury-arc rectifiers in the industry in the United States. He is a member of the Association of Iron and Steel Engineers.

L. N. Grier (AM '22, M '42), assistant chief electrical engineer, Aluminum Company of America, Pittsburgh, Pa., has been named chief electrical engineer. Mr. Grier has more than 30 years service with the company. Mr. Grier was graduated magna cum laude from Rutgers University in electrical engineering. He has assisted in the electric plans and specifications for practically all major building operations of Aluminum Company of America, as well as the introduction of the use of mercury-arc rectifiers in aluminum

reduction in the United States. Mr. Grier was made assistant chief electrical engineer in 1944. He has been a member of the Institute Committees on Industrial Power Systems (1946–49) and Mining and Metal Industry (1947–53).

C. M. Gilt (AM '21, F '35), assistant purchasing agent, Consolidated Edison Company of New York, N. Y., has been elected president of the New York State Society of Professional Engineers. Mr. Gilt has served Consolidated Edison both as inside plant engineer and outside plant engineer. He is a member of the American Society for Testing Materials and has been active in committee work of the Edison Electric Institute and the American Standards Association. Mr. Gilt has served on the following Institute committees: Electrical Machinery (1926–31, 1937–42, Chairman, 1940–42); Standards (1928–31, 1941–51); Technical Program (1940–42); and Transmission and Distribution (1942–44). **T. M. Linville** (AM '27, F '47), manager, Manager Development Services Department, Management Consultation Services Division, General Electric Company, New York, N. Y., has been elected first vice-president of the society.

D. M. Crawford (AM '32, M '46), secretary and treasurer, Duplan of Canada, Ltd., Montreal, Quebec, Canada, has been appointed co-ordinator for associated companies of the RCA International Division, Radio Corporation of America (RCA), New York, N. Y. The associated companies of RCA which operate outside the United States, are located in Argentina, Australia, Brazil, Canada, Chile, England, Greece, India, Italy, Mexico, and Spain. Mr. Crawford had been secretary and treasurer for Duplan of Canada, Ltd., since 1950. He served as assistant to the vice-president and treasurer of the Duplan Corporation, New York, N. Y., from 1946 to 1950. Between 1941 and 1946, Mr. Crawford was secretary of the J. G. White Engineering Corporation, New York, N. Y.

G. D. Montgomery (AM '32, M '38), air defense systems engineer, Bell Telephone Laboratories, Inc., Summit, N. J., has been named military communications manager, Long Lines Department, American Telephone and Telegraph Company, New York, N. Y. Mr. Montgomery began his career in Denver, Colo., as a student in the plant department of Long Lines. In 1938, he became division transmission engineer at Denver and a year later was transferred to Albuquerque, N. Mex., as district plant superintendent. During 1943 he served 5 months as a consultant on Communications and Air Navigation Aids, followed by a commission as major in the United States Air Force. The next 3 years were spent on Communication and Navigation Air planning in North Africa, Europe, and the Pacific. His military service was ended as a lieutenant colonel. In 1947 Mr. Montgomery joined the Operating and Engineering Department of the American Telephone and Telegraph Company and in 1951 was transferred to the Bell Laboratories.

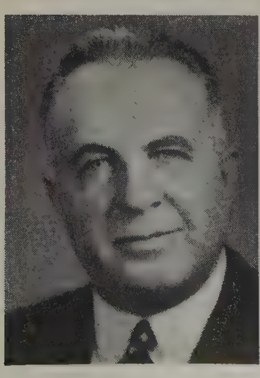
J. M. Pearce (M '50), president, Phebco, Inc., Baltimore, Md., has joined American Machine and Foundry Company, Electronics Division, Boston, Mass., as director of engineering. Mr. Pearce has been active in the field of radio and electronics since 1925. He holds the Presidential Citation of Merit in recognition of his contribution to the proximity fuse program at the Applied Physics Laboratory, Johns Hopkins University, Baltimore, during World War II. He was engaged in the guided missile program from 1947 to 1952 at the Glenn L. Martin Company of Baltimore as chief electronics engineer. Prior to that he was chief engineer in charge of development of guided missiles at Bendix Aviation Corporation, Pacific Division. For 17 years he was assistant chief engineer at radio station *WGN*, Chicago, Ill. Mr. Pearce is a member of the Institute of Radio Engineers.

K. S. Geiges (AM '31, F '51), chief electrical engineer, Chicago, New York, and San Francisco Electrical Divisions, Underwriters Laboratories, Inc., New York, N. Y., has been appointed chief engineer with headquarters in Chicago, Ill. Mr. Geiges graduated from Newark College of Engineering in 1928 with a bachelor of science degree in electrical engineering and in 1943 received his master of science degree at Stevens Institute of Technology. He joined the Laboratories staff in New York, N. Y., as an assistant electrical engineer in 1928. In 1940 he was appointed associate electrical engineer and in 1941 service engineer. After serving as electrical section chief, Conservation Division, War Production Board, Washington, D. C., in 1942 and 1943, Mr. Geiges spent the next 2 years in the United States Navy as assistant to Navy Chairman, Arm Navy Joint Specifications Board. He return to the Laboratories' New York Electric Division in 1946 as associate electrical eng neer and in 1951 was made chief electric engineer in charge of the Chicago, Ne York, and San Francisco Electrical Division Mr. Geiges has served on the AIEE Com mittees on Electronics (1947–49) and Meta lic Rectifiers (1949–52).

F. W. Packer (AM '21, M '41), transmissio engineer, Pennsylvania Power and Lig Company, Allentown, has retired after mo than 35 years of service. Mr. Packer, native of East Mauch Chunk, Pa., starte with the engineering department of th Lehigh Valley Railroad, Hazleton, Pa., i 1906. From 1908 to 1915 he was employe in an engineering capacity with the Charl M. Dodson Company, Beaverbrook, Pa In 1915 he joined the Hazleton Heights Im provement Company and in 1917, the Lehig Navigation Electric Company, becomin assistant transmission engineer in 1918. I 1922 he was employed by Pennsylvani Power and Light Company as transmissio engineer. Mr. Packer is a registered pro fessional engineer and is a member of th Edison Electric Institute, Committee o Revisions to the National Electrical Safet Code, the International Conference on Larg Electric High-Tension Systems, Nationa Society of Professional Engineers, and Penn sylvania Society of Professional Engineer He has served on the AIEE Committee o Transmission and Distribution (1946–48).

H. R. Arnold (AM '31, M '51), Westing house Electric Corporation, Philadelphia Pa., has been appointed assistant divisio manager of the Aviation Gas Turbine Divi sion; and **T. A. Daly** (AM '42, M '48), divi sion engineer, Ordnance Division, Westing house Electric Corporation, Sharon, Pa., ha been named manager of technical operation for the Aviation Gas Turbine Division. Mr Arnold joined Westinghouse in 1929 follow ing his graduation from the University o Colorado. He worked with the Trans former Division until 1941 when he entere government service. He served in engineer ing capacities with the United States Nav and the State Department overseas unti 1947, when he returned to Westinghouse He joined the Jet Division in 1952. Mr Daly, a graduate of Purdue University joined Westinghouse in 1942. Since then h has been engaged mainly in developmen work with the Ordnance Division.

E. F. Peterson (AM '33, M '45), manage of marketing, Tube Department, Genera Electric Company, Schenectady, N. Y., ha been appointed manager of marketing fo the Radio and Television Department, Syra cuse, N. Y. Mr. Peterson, a graduate o Kansas State College, joined the Genera Electric Company in 1933 and the Tub Department in 1934. He was placed i charge of design engineering for receivin tubes in 1943. In 1948 he was named assist ant manager of the Tube Department an was appointed manager of sales the followin year. In 1951 he was appointed manage of marketing.



D. I. Bohn

L. N. Grier

C. M. Gilt

W. J. Greene (AM '36), assistant manager, Metallurgical Process Division, Air Reduction Company, Murray Hill, N. J., has been named assistant director of Metallurgical Research. Mr. Greene joined Air Reduction in 1946 as a research and development engineer. In 1944 Mr. Greene was commissioned as a lieutenant in the United States Naval Reserve and until 1946 was assigned to the Radiation Laboratory, Massachusetts Institute of Technology, Cambridge, and the Naval Research Laboratory Field Station, Boston, Mass. A graduate of the Polytechnic Institute of Brooklyn in 1935, Mr. Greene also has been associated with Western Electric Company and General Electric Company.

M. C. Agress (AM '36, M '51), chief engineer, A. J. F. Industries, Inc., Brooklyn, N.Y., has become president and sales manager of the company. A graduate of Pratt Institute in 1939, Mr. Agress was formerly chief engineer, Penn Boiler and Burner Manufacturing Company, Lancaster, Pa., and project engineer, Lloyd Rogers and Company, New York, N. Y. Mr. Agress is a member of the Institute of Radio Engineers, Illuminating Engineering Society, American Electroplaters Society, and the New York State Society of Professional Engineers.

C. H. Bissell (M '32), vice-president of engineering, Crouse-Hinds Company, Syracuse, N. Y., has been awarded a certificate from National Electrical Manufacturers Association in recognition of 50 years of service in the electrical industry. Mr. Bissell began his career in 1900 as a draftsman with Onondaga Dynamo and Motor Company, Syracuse He joined Crouse-Hinds 2 years later. In 1907 he was made chief electrical engineer, a post he held until his appointment as vice-president in 1950.

H. E. Beane (AM '21, M '28), general sales manager, Bristol Company, Waterbury, Conn., has been named vice-president of sales. He joined Bristol sales engineering organization in 1920 and 5 years later was made district manager of the Birmingham, Ala., office. In 1930 he became district manager of the Pittsburgh, Pa., office. Mr. Beane was made sales manager of the Instrument Division in 1943 and was promoted to general sales manager in 1947.

J. T. Persons (M '45, F '51), vice-president and chief engineer, Central Power and Light Company, Corpus Christi, Tex., has retired after 25 years of service with the company. Mr. Persons joined Central Power and Light in 1927 as chief engineer. He has served as vice-president for the utility for the past 12 years and a director for 11 years. Prior to joining Central Power and Light, he was an engineer with the General Electric Company, Schenectady, N. Y., and Texas Power and Light Company, Dallas.

McNeely Du Bose (AM '14, F '43, Member for Life), vice-president, Aluminum Company of Canada, Ltd., Arvida, Quebec, Canada, has been named president of Saguenay Power Company, Ltd., Montreal, Quebec, Canada. Mr. Du Bose has been active in the management of the company for nearly 30 years. He served as engineer on the Isthmian Canal Commission, Panama, and with the Riegos y Fuerza del Ebro, Spain, before going to Canada in 1926, when he joined the Aluminum Company of Canada, Ltd. Mr. Du Bose is responsible for the major share of the planning and execution of the firm's development in British Columbia. He has served as vice-president of Aluminum Power Company and as president and director of Saguenay Electric Corporation and Saguenay Transmission Company, Ltd. He is a past president of the Canadian Electrical Association.

W. W. Wendelken (AM '43, M '45), chief electrical engineer of the headquarters works engineering department, Westinghouse Electric Corporation, Pittsburgh, Pa., has been appointed director of works engineering for the Headquarters Manufacturing Division. Mr. Wendelken began his career in works engineering in Westinghouse in 1917 at the East Pittsburgh, Pa., works in the power plant department. Two years later he moved to the works engineering department as a draftsman and in 1924 was appointed supervisor of lighting. In 1928 he was named works electrical engineer for the plant. He was appointed electrical superintendent of the construction department in 1941.

C. J. Beller (M '37, F '49), manager of electrical operations, The Cleveland (Ohio) Electric Illuminating Company, has been elected vice-president in charge of electrical operation and engineering. A 1924 graduate of Case Institute of Technology, Mr. Beller has been with the company for 28 years, advancing progressively through various engineering capacities to the position of assistant to the operations vice-president before receiving his managerial assignment 8 years ago. Mr. Beller has served on the AIEE Committees on Management (1948–53, Chairman 1951–53); Professional Division Advisory (1951–52); and Technical Operations (1952–53).

A. L. Carvill (AM '49, M '52), sales engineer, Meter and Instrument Department, General Electric Company, Lynn, Mass., has been named manager of electric utility field sales. Mr. Carvill was graduated from Massachusetts Institute of Technology in 1923 with a bachelor of science degree in engineering administration. He joined General Electric in 1947. **B. B. Gravitt** (AM '36, M '49), has been appointed manager of meter and time switch sales. Mr. Gravitt came to General Electric after he was graduated from California Institute of Technology in 1935. He was a sales engineer in the company's Los Angeles and San Diego, Calif., offices before moving to Lynn in 1951 as manager of instrument transformer sales. **J. A. Yunker** (AM '49), assistant manager of meter and time switch sales, has been named manager of instrument transformer sales. Mr. Yunker joined General Electric in 1948, having received his degree in electrical engineering from the University of Louisville in 1947.

T. D. Johnson (AM '49), Reliance Electric and Engineering Company, Cleveland, Ohio, has been appointed to the sales application engineering staff of the company's Atlanta, Ga., office. Mr. Johnson graduated from Clemson College in 1948 with a bachelor of science degree in electrical engineering and joined the Reliance organization in 1952.

OBITUARY • • • • • •

Forrest Eugene Ricketts (AM '16, F '50, Member for Life), retired, Consolidated Gas Electric Light and Power Company of Baltimore, Md., died July 3, 1953. Mr. Ricketts was born in Derwood, Md., February 18, 1878, and attended Columbian (now George Washington) University and Bliss Electrical School. In June 1942, the University of Maryland conferred upon him the honorary degree of doctor of engineering. He joined the Newport News (Va.) and Old Point Railway and Electric Company in 1902 as a lineman and wireman. Later he was with the Philadelphia Mining Company, Chloride, Ariz. He became an electrical repairman with the Los Angeles (Calif.) Pacific Railway and Electric Company before accepting a position as working foreman with the Potomac Electric Power Company, Washington, D. C. In 1905, Mr. Ricketts joined the Consolidated Gas Electric Light and Power Company of Baltimore as an electrician. He became chief operator of electric stations and advanced to superintendent of that department. Later he was appoined director of intersystem power utilization bureau, and in 1938 he was elected a vice-president. He retired in 1946. Mr. Ricketts was awarded the Lamme Medal by the Institute in 1941 "for his contribution to the high reliability of power-supply systems, especially in the design of apparatus for selective relaying and circuit reclosure." In 1940 the National Association of Manufacturers made him the recipient of the Modern Pioneer Award for his 16 inventions that contributed to the advancement of electric control apparatus. Mr. Ricketts had served on the AIEE Committees on Protective Devices (1917–24) and Transmission and Distribution (1919–21).

Henry Baldwin Dates (AM '98, M '13, F '32, Member for Life), retired, Grosse Pointe Woods, Mich., died May 17, 1953. Mr. Dates was born in New Britain, Conn., July 15, 1869, and graduated from Massachusetts Institute of Technology in 1894 with a bachelor of science degree in electrical engineering. After 2 years with Westinghouse Electric and Manufacturing Company (now Westinghouse Electric Corporation) in Newark, N. J., and East Pittsburgh, Pa., he became professor of physics and electrical engineering, Clarkson School of Technology, Potsdam, N. Y. In 1903 he became professor of electrical engineering and dean of the College of Engineering, University of Colorado, Boulder. From 1905 until his retirement in 1939, Professor Dates was professor of electrical engineering and head of the electrical engineering department, Case School of Applied Science (now Case Institute of Technology), Cleveland, Ohio.

He was also active in consulting engineering work, being particularly interested in the field of illumination. Professor Dates was a past president of the Illuminating Engineering Society and a member of the Illuminating Engineering Society of Great Britain, the Society for the Promotion of Engineering Education, and the United States National Committee of the International Commission of Illumination. He had served on the AIEE Committee on the Production and Application of Light (1935–41).

Charles le Maistre (AM '12), general secretary, International Electrotechnical Commission, Geneva, Switzerland, died July 5, 1953, at Bramley, Surrey, England. Mr. le Maistre was born in Jersey, Channel Islands, in 1874. He was educated at Brighton College and received his technical training at the Central Technical College, South Kensington, London. He was appointed assistant secretary to the British Standards Institution in 1902, becoming secretary in 1916, director in 1929, and chairman in 1939. He retired from the institution in 1941. Mr. le Maistre had lectured on standardization in many parts of the world. He was a Commander of the Order of the British Empire, member of the Institution of Electrical Engineers and associate member of the Institution of Civil Engineers, Great Britain, Knight Commander of the Royal Swedish Order of Vasa, and honorary member of the Royal Dutch Institution of Engineering.

Paul Melville Farmer (M '19), member of the executive staff, American District Telegraph Company, New York, N. Y., died May 7, 1953. Mr. Farmer was born in Macoupin County, Ill., August 23, 1885, and graduated from the University of Illinois in 1909 with a bachelor of science degree in electrical engineering. Following his graduation he joined Red Oak (Iowa) Electric Company, being responsible for rebuilding and changing over power generating plant and outside distributing system. He was with Westinghouse Electric Corporation and Western Electric Company for a number of years and also was assistant to the vice-president of DeForest Company and chief engineer of the Klaxon Company. He joined American District Telegraph in 1929 as assistant chief engineer, becoming chief engineer in 1935 and member of the executive staff in 1949.

Russell Hellegers (M '41), chief electrical engineer, Syska and Hennessy, Consulting Engineers, New York, N. Y., died recently. Mr. Hellegers was born in Passaic, N. J., June 17, 1904, and attended Columbia University. Since 1929 he had been with Syska and Hennessy as chief electrical engineer. He had served as consulting electrical engineer on the following projects: La Guardia Field Airport, New Criminal Courts Building, Flower and Fifth Avenue Hospitals, New York, N. Y.; Triboro Hospital, Jamaica, N. Y., and North Carolina Shipbuilding Company, Wilmington. He was serving on the AIEE Committee on the Production and Application of Light (1952–53) and was a member of the National Society of Professional Engineers.

Thomas Carter (F '20), engineering department, A. Reyrolle and Company, Ltd., Hebburn-on-Tyne, England, died June 16, 1953. Mr. Carter was born in Berwick-on-Tweed, England, January 21, 1877, and was educated at George Watson's College and Heriot-Watts College, Edinburgh, Scotland, completing his student days in Germany. He began his career with J. H. Holmes and Company, Newcastle-on-Tyne, England, with whom he became chief engineer before leaving to join A. Reyrolle and Company, Ltd., with whom he continued to be active in a consultative capacity until his death. Mr. Carter was a member of the Institutions of Civil and Electrical Engineers of Great Britian and had served on various committees of the British Electrical and Allied Manufacturers' Association and the British Standards Institution.

Keene Richards (AM '11, M '24, Member for Life), general manager, Vassar College, and consulting engineer, Poughkeepsie, N. Y., died July 6, 1953. Mr. Richards was born in Chicago, Ill., December 24, 1888, and attended the University of Illinois. From 1910 to 1917 he held engineering positions with various public utility companies. In World War I he served in the Signal Corps, rising to the rank of lieutenant colonel. From 1920 until 1925 when he came to Vassar he acted as industrial engineer with the Grennan Cake Corporation, Detroit, Mich. During World War II he was head of the Dutchess County Civil Defense organization and was reappointed Civil Defense Director in 1950. Mr. Richards was a member of The American Society of Mechanical Engineers.

Earl Bond Hansen (AM '26, M '36), toll transmission engineer, Pacific Telephone and Telegraph Company, Seattle, Wash., died July 3, 1953. Mr. Hansen was born December 20, 1896, at San Bernardino, Calif. He graduated in electrical engineering from the University of California in 1920 and joined the engineering department of the telephone company in San Francisco, Calif. During World War I he served as a lieutenant in the artillery and saw service in France. He was transferred to Seattle in 1926 where he supervised engineering of cable and open-wire carrier systems of all types. Mr. Hansen had been chairman of the Seattle Section of the AIEE (1945–46) and had served on the Committee on Wire Communications Systems.

MEMBERSHIP . . .

Recommended for Transfer

The Board of Examiners at its meeting of July 16, 1953, recommended the following members for transfer to the grade of membership indicated. Any objection to these transfers should be filed at once with the Secretary of the Institute. A statement of valid reasons for such objections, signed by a member, must be furnished and will be treated as confidential.

To Grade of Member

Brewer, E. W., electrical engineer, General Electric Co., Pittsburgh, Pa.
Brown, T. W., development engineer, Lombard Governor Corp., Ashland, Mass.
Cloninger, F. M., senior corrosion engineer, The Texas Pipe Line Co., Tulsa, Okla.
Doehne, R., electrical plant engineer, Public Service Electric & Gas Co., Newark, N. J.
DiVencenzo, A. P., electrical engineer, Reliance Electric & Engineering Co., Cleveland, Ohio
Evans, T. O., superintending engineer, substation sections, Quebec Hydro-Electric Commission, Montreal, Quebec, Canada
Farber, W. R., supervisory engineer, Westinghouse Electric Corp., Sharon, Pa.
Fritz, E., Jr., transmission line design engineer, Pennsylvania Water & Power Co., Baltimore, Md.
Gaubeca, J. B., electrical service supervisor, Westinghouse Electric Corp., New York, N. Y.
Goodrich, T. M., general manager & chief engineer, Pasadena Municipal Light & Power Dept., Pasadena, Calif.
Grannis, C. O., chief electrical engineer, Rader Engineering Co., Miami, Fla.
Grubb, R. K., assistant operating manager, Delaware Power & Light Co., Wilmington, Del.
Guthrie, G. R., engineer, Indianapolis Power & Light Co., Indianapolis, Ind.
Hall, R. C., senior starting engineer, Commonwealth Edison Co., Chicago, Ill.
Hinshaw, E. G., costs engineer, Indiana Bell Telephone Co., Indianapolis, Ind.
Howard, G. A., senior engineer, Consumers Power Co., Jackson, Mich.
Kadetsky, J. M., electrical equipment superintendent, Pennsylvania Electric Co., Johnstown, Pa.
Kliebenstein, W. M., estimator, General Electric Co., Richland, Wash.
Lennig, M., application engineer, General Electric Co., New York, N. Y.
Lewis, F. W., engineering manager, General Electric Co., Philadelphia, Pa.
Mathews, C. A., engineer, General Electric Co., Philadelphia, Pa.
Middleton, W. B., senior engineer, Michigan Bell Telephone Co., Detroit, Mich.
Moore, R. E., line supervisor, Kansas Gas & Electric Co., Independence, Kans.
Neslin, M. A., industrial engineer, General Electric Co., Schenectady, N. Y.
Oberhelman, L. E., head engineer, Standard Oil Co. (Indiana), Sugar Creek, Mo.
Owens, J. B., supervising engineer, Westinghouse Electric Corp., East Pittsburgh, Pa.
Pate, W. M., electrical engineer, Alabama Power Co., Birmingham, Ala.
Peters, R. R., engineer, Philadelphia Electric Co., Philadelphia, Pa.
Quimby, R. B., electrical engineer, General Electric Co., Schenectady, N. Y.
Richards, E. E., engineer, transportation dept., Ohio Brass Co., Mansfield, Ohio
Scharff, S. A., systems engineer, 366 Madison Ave., New York 17, N. Y.
Sexton, R. M., engineer, Westinghouse Electric Corp., East Pittsburgh, Pa.
Sielicki, A. J., electrical research engineer, A. O. Smith Corp., Milwaukee, Wis.
Smith, W. D., electrical design engineer, Portland General Electric Co., Portland, Oreg.
Smull, M. P., principal engineer, Southern Services, Inc., Birmingham, Ala.
Swenson, C. R., engineer, Indiana Bell Telephone Co., Indianapolis, Ind.
Toman, W. J. V., development engineer, Goodyear Aircraft Corp., Akron, Ohio
Treis, J. P., relay engineer, Knoxville Utilities Board, Knoxville, Tenn.
Vitale, S. A., engineer, long lines dept., American Tel. & Tel Co., New York, N. Y.
Waidhas, G., senior design engineer, A. O. Smith Corp., Milwaukee, Wis.
Welz, A. E., electrical engineer, Clark Controller Co., Cleveland, Ohio

41 to grade of Member

Applications for Election

Applications for admission or re-election to Institute membership, in the grades of Fellow and Member, have been received from the following candidates, and any member objecting to election should supply a signed statement to the Secretary before September 25, 1953, or November 25, 1953, if the applicant resides outside of the United States, Canada, or Mexico.

To Grade of Member

Apstein, M., National Bureau of Standards, Washington, D. C.
Begent, H. H., Messrs. Doulton & Co., Ltd., London, England
Harden, J. G., Indiana Bell Telephone Co., Indianapolis, Ind.
Strobel, L. A., The Detroit Edison Co., Detroit, Mich.
Weidner, C. K., American University of Beirut, Lebanese Republic

5 to grade of Member

AIEE Officers and Committees for 1953-1954

PRESIDENT

ELGIN B. ROBERTSON
Dallas, Texas
(*Term expires July 31, 1954*)

PAST PRESIDENTS

F. O. McMillan, Corvallis, Oreg.
(*Term expires July 31, 1954*)

Donald A. Quarles, Albuquerque, N. M.
(*Term expires July 31, 1955*)

VICE-PRESIDENTS

District
1 W. Scott Hill, Pittsfield, Mass.
3 M. D. Hooven, Newark, N. J.
5 W. L. Cassell, Ames, Iowa
7 C. M. Lytle, Kansas City, Mo.
9 T. Ingledow, Vancouver, B.C.
(*Terms expire July 31, 1954*)

District
2 W. B. Morton, Allentown, Pa.
4 C. P. Almon, Jr., Chattanooga, Tenn.
6 A. S. Anderson, Denver, Colo.
8 G. C. Tenney, San Francisco, Calif.
10 G. D. Floyd, Toronto, Ont.
(*Terms expire July 31, 1955*)

DIRECTORS

L. F. Hickernell, Hastings-on-Hudson, N. Y.
Victor Siegfried, Worcester, Mass.
(*Terms expire July 31, 1954*)

F. R. Benedict, Pittsburgh, Pa.
R. F. Danner, Oklahoma City, Okla.
D. D. Ewing, Lafayette, Ind.
(*Terms expire July 31, 1955*)

A. C. Muir, Philadelphia, Pa.
N. C. Pearcy, Chicago, Ill.
C. S. Purnell, New York, N. Y.
(*Terms expire July 31, 1956*)

D. I. Cone, San Francisco, Calif.
T. M. Linville, New York, N. Y.
E. W. Seeger, Milwaukee, Wis.
(*Terms expire July 31, 1957*)

TREASURER

Walter J. Barrett, Newark, N. J.
(*Term expires July 31, 1954*)

SECRETARY

H. H. Henline, New York, N. Y.

ASSISTANT SECRETARY

N. S. Hibshman, New York, N. Y.

LOCAL HONORARY SECRETARIES

Australia—V. J. F. Brain, Electricity Authority of N.S.W., Box 2600 G.P.O., Sydney, New South Wales

Brazil—W. L. Simpson, São Paulo Tramway Light and Power Company, Caixa Postal 8026, São Paulo

England—Sir A. P. M. Fleming, Metropolitan Vickers Electric Company, Trafford Park, Manchester 17

India, Northern—S. S. Kumar, P.W.D. Electricity Secretariat, Ellerslie, Simla-E, East Punjab

India, Southern—M. S. Thacker, Indian Institute of Science, Bangalore 3

Ireland—Gerard M. Mulhern, Transmission Dept., Electricity Supply Board, 27 Lower Fitzwilliam Street, Dublin

Japan—Stetfan Tanabe, 96 San-Chome, Denen-Chofu, Ohta-Ku, Tokyo

New Zealand—R. D. Neale, School of Engineering, Canterbury University College, Christchurch C.1

Pakistan—Mohamed Hussain Khalid, Electricity Department, Mardan

Sweden—Edy Velander, Box 5073, Stockholm 5

General Committees

Executive

Elgin B. Robertson, *Chairman*; Elgin B. Robertson, Inc., Dallas 3, Tex.
W. J. Barrett — Newark, N. J.
M. D. Hooven — Newark, N. J.
F. O. McMillan — Corvallis, Oreg.
C. S. Purnell — New York, N. Y.
D. A. Quarles — Albuquerque, N. Mex.
E. W. Seeger — Milwaukee, Wis.

Board of Examiners

C. W. Franklin, *Chairman;* Consolidated Edison Company of New York, Inc., 4 Irving Place, New York 3, N. Y.
L. F. Hickernell, *Vice-Chairman* — Hastings-on-Hudson, N. Y.
John J. Anderson, *Secretary* — AIEE Headquarters
P. H. Adams — Newark, N. J.
A. E. Anderson — Philadelphia, Pa.
R. W. Atkinson — Bayonne, N. J.
R. H. Barclay — New York, N. Y.
P. H. Chase — Philadelphia, Pa.
I. S. Coggeshall — New York, N. Y.
A. G. Conrad — New Haven, Conn.
A. S. Dana — Seymour, Conn.
E. W. Davis — Cambridge, Mass.
E. D. Doyle — Philadelphia, Pa.
W. N. Goodwin, Jr. — New Hope, Pa.
S. B. Griscom — East Pittsburgh, Pa.
P. H. Hatch — Erie, Pa.
R. A. Heising — New York, N. Y.
N. S. Hibshman — New York, N. Y.
J. W. Horton — New London, Conn.
C. T. Hughes — Waterbury, Conn.
A. E. Knowlton — New York, N. Y.
G. H. Landis — Poughkeepsie, N. Y.
Henry Logan — New York, N. Y.
J. B. MacLean — New York, N. Y.
E. C. Molina — East Orange, N. J.
H. P. St. Clair — New York, N. Y.
F. J. Scudder — Manhasset, N. Y.
H. P. Sparkes — New York, N. Y.
H. W. Tenney — Jersey City, N. J.
Gordon Thompson — New York, N. Y.
Robert Treat — Schenectady, N. Y.
H. M. Trueblood — Dobbs Ferry, N. Y.
B. Van Ness, Jr. — Baltimore, Md.
R. G. Warner — New Haven, Conn.
S. S. Watkins — New York, N. Y.
H. A. Wheeler — Great Neck, N. Y.
E. P. Yerkes — Philadelphia, Pa.

Charles LeGeyt Fortescue Fellowship

F. H. Pumphrey — Gainesville, Fla.
J. D. Ryder — Urbana, Ill.
(*Terms expire July 31, 1954*)
D. S. Bridgman — New York, N. Y.
E. A. Walker, *Chairman* — State College, Pa.
(*Terms expire July 31, 1955*)
E. T. B. Gross — Chicago, Ill.
G. E. Moore — East Pittsburgh, Pa.
(*Terms expire July 31, 1956*)

Code of Principles of Professional Conduct

W. B. Kouwenhoven, *Chairman;* The Johns Hopkins University, Baltimore 18, Md.
P. L. Alger — Schenectady, N. Y.

R. E. Argersinger	Boston, Mass.
W. C. DuVall	Boulder, Colo.
A. H. Kidder	Philadelphia, Pa.
Walter J. Seeley	Durham, N. C.
R. W. Sorensen	Pasadena, Calif.
S. Reid Warren, Jr.	Philadelphia, Pa.
J. S. Waters	Houston, Tex.

Constitution and Bylaws

D. D. Ewing, *Chairman;* Purdue University, Lafayette, Ind.

F. S. Black	New York, N. Y.
Harold J. Karr	Springfield, Ohio
W. W. Lewis	Schenectady, N. Y.
W. S. Peterson	Los Angeles, Calif.

Edison Medal

Appointed by the President for term of five years

J. L. Callahan	New York, N. Y.
J. M. Flanigen	Atlanta, Ga.
R. I. Wilkinson	New York, N. Y.
	(*Terms expire July 31, 1954*)
J. F. Calvert	Evanston, Ill.
B. A. Case	New York, N. Y.
John Grotzinger	Akron, Ohio
	(*Terms expire July 31, 1955*)
A. H. Frampton	Toronto, Ontario, Canada
J. R. North	Jackson, Mich.
B. R. Teare, Jr.	Pittsburgh, Pa.
	(*Terms expire July 31, 1956*)
O. B. Blackwell	Plandome, N. Y.
J. F. Fairman, *Chairman*	New York, N. Y.
K. B. McEachron	Pittsfield, Mass.
	(*Terms expire July 31, 1957*)
S. S. Attwood	Ann Arbor, Mich.
Charles F. Wagner	East Pittsburgh, Pa.
P. G. Wallace	Dallas, Tex.
	(*Terms expire July 31, 1958*)

Members of the Board of Directors elected by the Board for term of two years

F. O. McMillan	Corvallis, Oreg.
C. S. Purnell	New York, N. Y.
Elgin B. Robertson	Dallas, Tex.
	(*Terms expire July 31, 1954*)
F. R. Benedict	Pittsburgh, Pa.
D. D. Ewing	Lafayette, Ind.
D. A. Quarles	Albuquerque, N. Mex.
	(*Terms expire July 31, 1955*)

Education

J. D. Ryder, *Chairman;* University of Illinois, Elec. Engg. Dept., Urbana, Ill.

Guy Kleis, *Vice-Chairman*	East Pittsburgh, Pa.
I. B. Baccus, *Secretary*	East Lansing, Mich.
E. D. Ayres	Columbus, Ohio
E. W. Boehne	Cambridge, Mass.
C. G. Brennecke	Raleigh, N. C.
D. S. Bridgman	New York, N. Y.
E. M. Brohl	Flint, Mich.
C. V. Bullen	Lubbock, Tex.
M. S. Coover	Ames, Iowa
F. A. Eastom	Boulder, Colo.
C. L. Farrar	Norman, Okla.
W. B. Fisk, Jr.	New York, N. Y.
A. W. Friend	Camden, N. J.
F. Hamburger, Jr.	Baltimore, Md.
H. E. Hartig	Minneapolis, Minn.
A. R. Hellwarth	Detroit, Mich.
R. J. W. Koopman	St. Louis, Mo.
F. C. Lindvall	Pasadena, Calif.
T. C. Lloyd	Springfield, Ohio
R. W. McFall	Schenectady, N. Y.
T. C. McFarland	Berkeley, Calif.
E. W. Morris	Los Angeles, Calif.
H. A. Peterson	Madison, Wis.
E. F. Smith	Gainesville, Fla.
E. M. Strong	Ithaca, N. Y.
B. R. Teare, Jr.	Pittsburgh, Pa.
G. F. Tracy	Toronto, Ontario, Canada
E. A. Walker	State College, Pa.
S. Reid Warren, Jr.	Philadelphia, Pa.

Finance

C. S. Purnell, *Chairman;* Westinghouse Electric Corporation, 40 Wall Street, New York 5, N. Y.

F. R. Benedict	Pittsburgh, Pa.
M. D. Hooven	Newark, N. J.

Headquarters

J. P. Neubauer, *Chairman;* Consolidated Edison Company of New York, Inc., 4 Irving Place, New York 3, N. Y.

J. A. Parrott	New York, N. Y.
C. S. Purnell	New York, N. Y.

Lamme Medal

A. M. MacCutcheon	Orlando, Fla.
B. L. Robertson	Berkeley, Calif.
Elgin B. Robertson	Dallas, Tex.
	(*Terms expire July 31, 1954*)
S. B. Crary	Schenectady, N. Y.
A. C. Monteith, *Chairman*	Pittsburgh, Pa.
J. S. Moulton	San Francisco, Calif.
	(*Terms expire July 31, 1955*)
O. S. Hockaday	Fort Worth, Tex.
J. J. Pilliod	Scarsdale, N. Y.
E. W. Seeger	Milwaukee, Wis.
	(*Terms expire July 31, 1956*)

Managment

F. K. McCune, *Chairman;* General Electric Company, 1 River Road, Schenectady 5, N. Y.

E. D. Ayres	Columbus, Ohio
C. J. Beller	Cleveland, Ohio
W. L. Cisler	Detroit, Mich.
L. W. Clark	Detroit, Mich.
L. R. Gaty	Philadelphia, Pa.
E. E. Hill	New York, N. Y.
H. O. Hodson	Amarillo, Tex.
E. E. Johnson	Schenectady, N. Y.
S. A. Langell	Canton, Ohio
John Magee	Baltimore, Md.
A. C. Monteith	Pittsburgh, Pa.
H. W. Oetinger	Charlotte, N. C.
J. L. Pratt	Dallas, Tex.
H. H. Race	Schenectady, N. Y.
G. W. Spaulding	Baltimore, Md.
W. W. Sproul, Jr.	Pittsburgh, Pa.
Earle Wild	Chicago, Ill.

Members-for-Life Fund

C. A. Powel, *Chairman;* 93 Beacon Street, Boston 8, Mass.

C. L. Dawes	Cambridge, Mass.
D. D. Ewing	Lafayette, Ind.
N. E. Funk	Philadelphia, Pa.
J. J. Pilliod	Scarsdale, N. Y.
R. W. Sorensen	Pasadena, Calif.
F. C. Weiss	Birmingham, Ala.

Membership

Charles Clos, *Chairman;* Bell Telephone Laboratories, Inc., 463 West Street, New York 14, N. Y.

W. E. Scholz, *Vice-Chairman*	Philadelphia, Pa.
F. A. Norris, *Secretary*	AIEE Headquarters
W. A. Dynes	Dayton, Ohio
H. R. Heckendorn	Chicago, Ill.
W. Scott Hill	Schenectady, N. Y.
H. B. Hodgins	Salt Lake City, Utah
M. A. Jones	Newark, N. J.
E. W. Morris	Los Angeles, Calif.
Russell Ranson	Charlotte, N. C.
R. W. Shaw	Omaha, Nebr.
M. C. Thurling	Toronto, Ontario, Canada
V. B. Wilfley	St. Louis, Mo.

District Vice-Chairmen

1	E. F. Hansen	Lynn, Mass.
2	F. E. Martin	Washington, D. C.
3	G. W. Cross	New York, N. Y.
4	E. R. Coulbourn	Birmingham, Ala.
5	C. M. Summers	Fort Wayne, Ind.
6	O. P. Settles	Denver, Colo.
7	T. M. Keiller	Houston, Tex.
8	W. F. Poynter	San Francisco, Calif.
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Richmond (Virginia Section)	J. A. Ritchie	O. A. Palmer	2903 Kenwood Avenue, Richmond, Va.
St. Lawrence International (Syracuse Section)	C. I. Bacon	J. A. Gurnham	Cornwall St. Ry. Lt. & Pr. Co. Ltd., 16 Second St., East, Cornwall, Ont.
St. Maurice Valley (Montreal Section)	H. P. Mongrain	A. P. Earle, Jr.	The Shawinigan Water & Power Co., P. O. Box 125, Trois-Rivieres, Que.
San Jose (San Francisco Section)	F. E. Miller	E. C. Glover	233 North Claremont Ave., San Jose 27, Calif.
Savannah (Georgia Section)	J. K. Walsh	C. O. Durant	U. S. Corps of Engineers, Savannah, Ga.
Shasta Division (San Francisco Section)	W. M. Reed	G. D. Atkinson	c/o U. S. B. R.—Shasta Dam, Redding, Calif.
Tacoma (Seattle Section)	E. E. Martin	B. C. West	Pacific Oerlikon Co., P. O. 1133, Tacoma 1, Wash.
Tullahoma (East Tennessee Section)	G. C. LaCook	E. D. Phillips	Route #1, Tullahoma, Tenn.
Vancouver Island (Vancouver Section)	L. A. Patterson	J. Oxendale	B. C. Electric Rly. Co., Victoria, B. C.
Wenatchee (Spokane Section)	W. E. Mathews	R. V. Wachter	Aluminum Company of America, Wenatchee, Wash.
West Central Texas Division (North Texas Section)	C. A. Glover	J. A. Hutchison	Box 841, Abilene, Tex.
West Michigan (Michigan Section)	L. A. Zahorsky	Charles C. Day	Consumers Power Co., 129 Pearl St., N. W. 2, Grand Rapids, Mich.
Youngstown (Sharon Section)			
Zanesville (Columbus Section)	J. Charles Joublanc	Daniel Blumenthal	Line Material Co., Zanesville, Ohio
Total Subsections......55			

Sections

Name	District	When Organized	Chairman	Secretary	Secretary's Address
Akron	2	Aug. 12, '20	P. O. Huss	T. C. Dee	604 Ardleigh Drive, Akron 3, Ohio
Alabama	4	May 22, '29	E. C. Gentle, Jr.	G. B. Campbell	Southern Services, Inc., Birmingham, Ala.
Arizona	8	Mar. 22, '41	K. V. Fletcher	R. H. Hartley	P. O Box 6144, Phoenix, Ariz.
Arkansas	7	Apr. 23, '47	W A. Bost	D. A. Schmand	U. S. Engineers, 300 Broadway, Little Rock, Ark.
Arrowhead	5	Apr. 23, '47	H. C. Sargent	V. M. Sovick	Oliver Iron Mining Co., Duluth, Minn.
Beaumont	7	June 27, '45	R. W. Sherwood	H. J. Sutton	Gulf States Utilities Co., 362 Liberty Ave., Beaumont, Tex.
Boston	1	Feb. 13, '03	W. F. Potter	L. T. Jester, Jr.	General Electric Company, 140 Federal St., Boston 1, Mass.
Canton	2	Nov. 5, '47	C. J. Muckley	C. R. Blyth	The Hoover Company, North Canton, Ohio
Central Illinois	5	June 28, '51	C. R. Schultz	George Sangster	Sangamo Electric Company, Springfield, Ill.
Central Indiana	5	Jan. 12, '12	G. R. Guthrie	L. H. Wollenweber	Eli Lilly Co., 1202 Kentucky Ave., Indianapolis, Ind.
Chicago	5	1893	R. W. Jones	H. R. Heckendorn	Western Electric Co., Inc., Hawthorne Station, Chicago 23, Ill.
Cincinnati	2	June 30, '20	J. P. Quitter	H. S. Progler	Westinghouse Electric Corp., 207 West Third St., Cincinnati 2, Ohio
Cleveland	2	Sept. 27, '07	J. A. Cortelli	R. C. Berger	General Electric Co., 4966 Woodland Ave., Cleveland, Ohio
Columbus	2	Mar. 17, '22	E. K. McCoy	G. W. Holton	609 East Dominion Blvd., Columbus 14, Ohio
Connecticut	1	Apr. 16, '21	Theodore Braaten	M. B. Sprague	The Southern New England Tel. Co., 227 Church St., New Haven 6, Conn.
Corpus Christi	7	Oct. 25, '51	J. R. Dickey	O. A. Boyer	Central Power & Light Co., Corpus Christi, Tex.
Dayton	2	June 9, '43	D. D. Colker	R. H. Neal	Dayton Power & Light Co., 25 North Main St., Dayton, Ohio
Delaware Bay	2	June 1, '52	R. E. Seddon	F. A. Anderson	E. I. Du Pont de Nemours & Co., Wilmington 98, Del.
Denver	6	May 18, '15	H. F. Gidlund	A. E. Paige	University of Denver, Dept. of Elec. Engg., Denver, Colo.
East Tennessee	4	Sept. 2, '36	J. W. Roberts	L. J. Munson	Tennessee Valley Authority, 311 Power Bldg., Chattanooga, Tenn.
El Paso	7	Mar. 7, '40	R. L. Riese	N. C. Peyton	El Paso Electric Co., El Paso, Tex.
Erie	2	Jan. 11, '18	Richard Lamborn	T. J. Warrick	General Electric Co., Erie, Pa.
Fort Wayne	5	Aug. 14, '08	M. L. Miller	D. F. Wartzok	4319 S. Anthony, Fort Wayne, Ind.
Georgia	4	Jan. 14, '04	W. H. Hickey, Jr.	J. C. Ager	General Electric Co., Red Rock Bldg., Atlanta, Ga.
Hamilton	10	May 1, '53	L. G. Stopps	E. L. Lyons	Canadian Westinghouse Co. Ltd., Hamilton, Ont.
Houston	7	Aug. 7, '28	T A. Standish	Harold Kongabel	Westinghouse Electric Corp., Petroleum Bldg., Houston, Tex.
Illinois Valley	5	June 30, '45	E. B. Oberlander	J. L. Ranney	105 Wilson Drive, Peoria, Ill.
Iowa	5	June 29, '29	C. C. Doerrie	W. G. Kaldenberg	Iowa Power & Light Co., 823 Walnut St., Des Moines, Iowa
Ithaca	1	Oct. 15, '02	W. R. Jones	K. Personius	New York State Elec. & Gas Corp., Lake & Water Sts., Elmira, N. Y.
Jacksonville	4	Jan. 28, '31	E. F. Smith	W. T. Sams	Westinghouse Electric Corp., 545 E. 4th St., Jacksonville, Fla.
Kansas City	7	Apr. 14, '16	J. C. Bibbs	O. A. Starcke	Kansas City Power & Light Co., 1330 Baltimore Ave., Kansas City 10, Mo.
Lehigh Valley	2	Apr. 16, '21	J. H. Black	W. C. Seymour	Pennsylvania Power & Light Co., 117 East Broad St., Hazleton, Pa.
Los Angeles	8	May 19, '08	C. A. Wells	W. S. Peterson	Box 3669, Terminal Annex, Los Angeles 54, Calif.
Louisville	4	Oct. 15, '26	J. D. Warren	T. W. Talcott	Southern Bell Tel. & Tel. Co., P. O. Box 538, Louisville, Ky.
Lynn	1	Aug. 22, '11	E. K. Rohr		
Madison	5	Jan. 8, '09	N. L. Schmitz	R. R. Caldwell	University of Wisconsin, New Engineering Bldg., Madison 6, Wis.
Mansfield	2	Mar. 6, '39	W. H. Blashfield	C. J. Andrews	North Electric Mfg. Co., Galion, Ohio
Maryland	2	Dec. 16, '04	C. W. Watchorn	W. B. Mann	The Wolfe & Mann Mfg. Co., 28th and Sisson Sts., Baltimore 11, Md.
Memphis	4	May 22, '30	W. C. Jordan, Jr.	John Thrithart	General Electric Co., 8 North 3rd St., Memphis, Tenn.
Mexico	7	June 29, '22	H. M. D'Meza	J. O. de Rosas	Calle de Palma 33, Despacho 210, Mexico 1, D. F., Mexico
Miami	4	Feb. 3, '49	R. L. Poor		
Michigan	5	Jan. 13, '11	H. E. Crampton	J. J. Carey	Dept. of Elec. Engg., University of Michigan, Ann Arbor, Mich.
Milwaukee	5	Feb. 11, '10	H. C. Brem	N. C. Storck	Wisconsin Electric Power, 231 W. Michigan St., Milwaukee 3, Wis.
Minnesota	5	Apr. 7, '02	R. E. Willey	J. J. Rudolf, Jr.	Minneapolis-Honeywell Reg. Co., 2600 Ridgway Road, Minneapolis 13, Minn.
Mississippi	4	June 28, '51	J. L. Maxwell	R. D. Yarbrough	Southern Bell Tel. & Tel. Co., P. O. Box 811, Jackson, Miss.
Mobile-Pensacola	4	Jan. 22, '53	R. E. Pride	C. S. Weiss	Southern Bell Tel. & Tel. Co., 100 N. Franklin St., Mobile, Ala.
Montana	9	June 24, '31	R. C. Setterstrom	R. J. Labrie	Montana Power Co., 40 E. Broadway, Butte, Mont.
Montreal	10	Apr. 16, '43	L. Roy	D. King	The Shawinigan Water & Power Co., 600 Dorchester St. W., Montreal, Que.
Nashville	4	June 28, '51	C. A. McNutt	R. B. Sanderford	Tennessee Valley Authority, 717 Church St., Nashville 3, Tenn.
Nebraska	6	Jan. 21, '25	A. G. Johnson	O. H. Brand	Nebraska Public Power System, Box 728, Bellevue, Nebr.
New Orleans	4	Dec. 8, '33	J. C. Ryan	D. H. Vliet	Tulane University, New Orleans, La.
New York	3	Dec. 10, '19	L. F. Stone	R. T. Weil	Manhattan College, New York 63, N. Y.
Niagara Frontier	1	Feb. 10, '25	T. O. Zittel	R. A. Beuerman	E. I. du Pont de Nemours & Co., Film Research Sect., P. O. Sta. B, Buffalo 7, N. Y.
Niagara International	10	Aug. 5, '48	P. W. Shill	W. D. Brown	1657 Prince Edward Ave., Niagara Falls, Ont.
North Carolina	4	Mar. 21, '29	C. R. Vail	A. J. Hill	General Electric Co., Box 2507, Raleigh, N. C.
Northeastern Michigan	5	Feb. 2, '50	G. W. Miller	W. F. Schultz	625—7th Ave., Owosso, Mich.
Northern New Mexico	7	Jan. 25, '51	E. H. Craven	F. T. Sinnott	Sandia Corporation, Sandia Base, Albuquerque, N. Mex.
North Texas	7	May 18, '28	C. F. Crandell	P. S. Neblett	Elgin B. Robertson, Inc., 1339 Plowman St., Dallas 3, Tex.
Oak Ridge	4	Feb. 1950			
Ohio Valley	2	June 28, '51	H. C. Willey	Carl Latta	22–24 Adams Avenue, Huntington, W. Va.
Oklahoma City	7	Feb. 16, '22	R. J. Thompson	E. L. Hassler	Southwestern Bell Telephone Co., Oklahoma City, Okla.
Ottawa	10	June 23, '49	G. H. Dawson	R. H. McCabe	286 Bayswater Ave., Ottawa, Ont.
Panhandle Plains	7	June 12, '47	P. S. Sterrett	M. J. Smith	New Mexico Elec. Serv. Corp., Hobbs, N. Mex.
Philadelphia	2	Feb. 18, '03	W. F. Denkhaus	B. H. Zacherle	United Engineers & Construction Inc., 1401 Arch St., Philadelphia 2, Pa.
Pittsburgh	2	Oct. 13, '02	B. R. Teare, Jr.	E. S. Reeser	General Electric Company, 2116 Oliver Bldg., Pittsburgh 22, Pa.
Pittsfield	1	Mar. 25, '04	F. H. Judkins	W. W. Green	General Electric Company, 100 Woodlawn Avenue, Pittsfield, Mass.
Portland	9	May 18, '09	D. A. Riechel	D E. Heym	U. S. Corps of Engineers, Pittock Block, Portland, Oreg.
Providence	1	Mar. 12, '20	L. A. Baltzell	C. B. Leathers	General Electric Company, 111 Westminster St., Providence, R. I.
Richland	9	Apr. 23, '48	E. P. Peabody	E. J. Barrett	General Electric Company, Hanford Works, Richland, Wash.
Ridgway	2	June 26, '52	W. P. Van Vranken	C. E. Sassman	c/o West Penn Power Company, Ridgway, Pa.
Rochester	1	Oct. 9, '14	F. C. Starr	A. V. Dasburg	General Railway Signal Co , Rochester, N. Y.
Rock River Valley	5	Apr. 23, '47	J. H. Petersen	E. A. Brown	201 Third St., Rockford, Ill.
Sacramento	8	June 15, '50	J. W. Mueller	F. J. Groat	Water Resources Div., State of Calif., Public Works Bldg., Sacramento, Calif.
St. Louis	7	Jan. 14, '03	R. W. Schoetker	V. B. Wilfley	Westinghouse Electric Corp., 411 North 7th Street, St. Louis 1, Mo.
San Diego	8	Jan. 18, '39	I. E. McDougal	E. F. Kotnik	Route 1, Box 652, El Cajon, Calif.
San Francisco	8	Dec. 23, '04	W. R. Johnson	W. Ridgway	General Electric Company, 235 Montgomery St., San Francisco, Calif.
Schenectady	1	Jan. 26, '03	C. C. Herskind	R. K. Fairley	General Electric Company, Bldg. 5, Room 209-B, Schenectady 5, N. Y.
Seattle	9	Jan. 19, '04	J. M. Nelson	W. J. Smith	Puget Sound Power & Light Co., 601 Electric Bldg., Seattle, Wash.
Sharon	2	Dec. 11, '25	E. C. Wentz	Saul Bennon	Westinghouse Electric Corp., Sharon, Pa.
Shreveport	7	June 12, '47	T. W. Landrum	E. C. Riall, Jr.	231 E. Slattery, Shreveport, La.
South Bend	5	Feb. 26, '41	Virgil Williams	James Evans	Jackson Road, Route 2, Mishawaka, Ind.
South Carolina	4	Mar. 2, '40	Oren Long		
South Texas	7	May 23, '30	J. C. Smith	H. G. Robinson	Box 1160, Austin, Tex.
Spokane	9	Feb. 14, '13	Charles Uhden	H. C. Martindale	Westinghouse Electric Corp., 1023 West Riverside Ave., Spokane 8, Wash.
Springfield	1	June 29, '22	D. L. Ross	A. G. Payne	Monsanto Chemical Co., Plastics Div., Springfield, Mass.
Susquehanna	2	June 18, '53	K. J. Granbois	P. W. Kaseman	Radio Corp. of America, Lancaster, Pa.
Syracuse	1	Aug. 12, '20	Bernard Cole	Thomas De Vore	Niagara Mohawk Power Corp., 300 Erie Blvd., West, Syracuse 2, N. Y.
Tampa	4	Feb. 1, '52	I. L. Garcia	N. J. Patterson	3902 McKay Avenue, Tampa, Fla.
Toledo	2	June 3, '07	J. B. Cloer, Jr.	J. W. Cofer	Toledo Edison Company, 420 Madison Avenue, Toledo 4, Ohio
Toronto	10	Sept. 30, '03	W. R. Harmer	R. J. Brown	Moloney Electric Co., 213 Sterling Road, Toronto 3, Ont.
Tulsa	7	Oct. 1, '37	H. M. Furtney	C. C. Flora	Southwestern Bell Telephone Co., 424 South Detroit, Tulsa 3, Okla.
Utah	9	Mar. 9, '17	J. V. Sharp	V. E. Clayton	1525 Browning Ave., Salt Lake City 5, Utah
Vancouver	9	Aug. 22, '11	C. E. Woolgar	J. T. Turner	Oakridge Transit Centre, B. C. Electric Co., Ltd., Vancouver, B. C.
Virginia	4	May 19, '22	A. I. Osborne	D. N. Rice	Virginia Electric & Power Co., Box 1194, Richmond 9, Va.
Virginia Mountain	4	June 23, '49	E. L. Munday, Jr.	J. S. Jamison, Jr.	Virginia Military Institute, Lexington, Va.
Washington	2	Apr. 9, '03	G. G. Coleman	M. M. Moore	Federal Power Commission, 2703 Elnora St., Wheaton Station, Silver Spring, Md.
West Virginia	2	Apr. 9, '40	John Vodar, Jr.	R. H. Hively	408½ Greenbrier Street, Charleston, W. Va.
Wichita	7	Sept. 16, '37	D. P. Hutchison	H. B. Hamilton	General Electric Company, 200 East First St., Wichita, Kans.
Worcester	1	Feb. 18, '20	D. C. Alexander	D. Jack Allia	New England Power Service Co., 66 Faraday St., Worcester, Mass.

Total Sections........99

Student Branches

Name and Location	District	Counselor (Member of Faculty)
*Akron, University of, Akron, Ohio	2	Kenneth F. Sibila
Alabama Polytechnic Institute, Auburn	4	Albert T. Sprague, Jr.
Alabama, University of, University	4	W. F. Gray
*Alberta, University of, Edmonton, Canada	10	R. E. Phillips
*Arizona, University of, Tucson	8	
*Arkansas, University of, Fayetteville	7	D. D. Lingelbach
*British Columbia, University of, Vancouver, Canada	9	S. C. Morgan
Brooklyn, Polytechnic Institute of, Brooklyn, N. Y., (Day)	3	
Brooklyn, Polytechnic Institute of, Brooklyn, N. Y., (Evening)	3	
*Brown University, Providence, R. I.	1	M. F. Gordon
*Bucknell University, Lewisburg, Pa.	2	J. B. Miller
*California Institute of Technology, Pasadena	8	
*California, University of, Berkeley	8	
*Carnegie Institute of Technology, Pittsburgh, Pa.	2	L. A. Finzi
Case Institute of Technology, Cleveland, Ohio	2	N. E. Prochaska
Catholic University of America, Washington, D. C.	2	J. C. Michalowicz
Cincinnati, University of, Cincinnati, Ohio	2	C. F. Evert, Jr.
Clarkson College of Technology, Potsdam, N. Y.	1	John Adams
Clemson A & M College, Clemson, S. C.	4	F. T. Tingley
Colorado A & M College, Fort Collins	6	J. E. Dean
*Colorado, University of, Boulder	6	S. I. Pearson
*Columbia University, New York, N. Y.	3	
*Connecticut, University of, Storrs	1	V. B. Haas
*Cooper Union, New York, N. Y.	3	
*Cornell University, Ithaca, N. Y.	1	M. G. Malti
*Dayton, University of, Dayton, Ohio	2	L. H. Rose
*Delaware, University of, Newark	2	H. S. Bueche
*Denver, University of, Denver, Colo.	6	A. E. Paige
*Detroit, University of, Detroit, Mich.	5	R. W. Ahlquist
*Drexel Institute of Technology, Philadelphia, Pa.	2	F. C. Powell
Duke University, Durham, N. C.	4	C. R. Vail
Fenn College, Cleveland, Ohio	2	R. W. Schindler
*Florida, University of, Gainesville	4	P. H. Nelson
George Washington University, Washington, D. C.	2	Norman B. Ames
Georgia Institute of Technology, Atlanta	4	E. R. Weston
Howard University, Washington, D. C.	2	E. R. Welch
Idaho, University of, Moscow	9	J. Hugo Johnson
Illinois Institute of Technology, Chicago	5	E. T. B. Gross
*Illinois, University of, Urbana, and Chicago Division, Chicago	5	E. A. Reid
*Iowa State College, Ames	5	G. A. Richardson
Iowa, University of, Iowa City	5	E. B. Kurtz
*Johns Hopkins University, Baltimore, Md.	2	J. L. Artley
Kansas State College, Manhattan	7	E. L. Sitz
*Kansas, University of, Lawrence	7	E. L. Jordon
Kentucky, University of, Lexington	4	G. E. Smith
*Lafayette College, Easton, Pa.	2	J. G. Reifsnyder
Laval University, Quebec, Canada	10	G. E. Sarault
Lehigh University, Bethlehem, Pa.	2	H. T. MacFarland
Louisiana Polytechnic Institute, Ruston	7	L. M. Dyson
*Louisiana State University, Baton Rouge	4	A. K. Ramsey
Louisville, University of, Louisville, Ky.	4	M. G. Northrop
*Maine, University of, Orono	1	
*Manhattan College, New York, N. Y.	3	R. T. Weil
*Marquette University, Milwaukee, Wis.	5	E. W. Kane
*Maryland, University of, College Park	2	L. J. Hodgins
*Massachusetts Institute of Technology, Cambridge	1	
*Massachusetts, University of, Amherst	1	J. W. Mohn
*Michigan College of Mining and Technology, Houghton	5	G. W. Swenson
*Michigan State College, East Lansing	5	T. W. Culpepper
*Michigan, University of, Ann Arbor	5	J. J. Carey
Milwaukee School of Engineering, Milwaukee, Wis.	5	R. J. Ungrodt
*Minnesota, University of, Minneapolis	5	P. A. Cartwright
Mississippi State College, State College	4	J. C. McKee, Jr.
*Missouri School of Mines and Metallurgy, Rolla	7	J. W. Rittenhouse
*Missouri, University of, Columbia	7	J. R. Tudor
*Montana State College, Bozeman	9	R. F. Durnford
*Nebraska, University of, Lincoln	6	E. J. Ballard, Jr.
Nevada, University of, Reno	8	
Newark College of Engineering, Newark, N. J.	3	R. E. Anderson
*New Hampshire, University of, Durham	1	J. B. Hraba
*New Mexico College of A & M Arts, State College	7	C. D. Crosno
*New Mexico, University of, Albuquerque	7	J. L. Ellis
*New York, College of the City of, New York	3	
*New York University, New York, (Day)	3	
*New York University, New York, (Evening)	3	
*North Carolina State College, Raleigh	4	W. D. Stevenson, Jr.
*North Dakota State College, Fargo	5	R. N. Faiman
*North Dakota, University of, Grand Forks	5	
*Northeastern University, Boston, Mass	1	R. G. Porter
*Northwestern University, Evanston, Ill	5	A. H. Wing
Norwich University, Northfield, Vt.	1	T. M. Riley
*Notre Dame, University of, Notre Dame, Ind	5	L. F. Stauder
Ohio Northern University, Ada	2	J. L. Klingenberger
*Ohio State University, Columbus	2	N. A. Smith
*Ohio University, Athens	2	D. B. Green
*Oklahoma A & M College, Stillwater	7	D. L. Johnson
Oklahoma, University of, Norman	7	J. Bruce Wiley
*Oregon State College, Corvallis	9	L. N. Stone
*Pennsylvania State College, State College	2	A. P. Powell
*Pennsylvania, University of, Philadelphia	2	Ernest Frank
Pittsburgh, University of, Pittsburgh, Pa.	2	R. C. Gorham
*Pratt Institute, Brooklyn, N. Y.	3	
*Princeton University, Princeton, N. J.	2	C. H. Willis
Puerto Rico, University of, Mayaguez	3	
Purdue University, Lafayette, Ind.	5	S. Freeman, Jr.
*Rensselaer Polytechnic Institute, Troy, N. Y.	1	E. D. Broadwell
*Rhode Island, University of, Kingston	1	V. J. Maggioli
Rice Institute, Houston, Tex.	7	P. E. Pfeiffer
Rose Polytechnic Institute, Terre Haute, Ind.	5	R. D. Strum
*Rutgers University, New Brunswick, N. J.	3	
Saint Louis University, St. Louis, Mo.	7	W. M. McCabe
Santa Clara, University of, Santa Clara, Calif.	8	
*South Carolina, University of, Columbia	4	J. H. Noland, Jr.
*South Dakota School of Mines and Technology, Rapid City	6	A. R. Colgan
South Dakota State College, Brookings	5	J. N. Cheadle
*Southern California, University of, Los Angeles	8	
*Southern Methodist University, Dallas, Tex.	7	W. W. Koepsel
*Stanford University, Stanford, Calif.	8	
*Stevens Institute of Technology, Hoboken, N. J.	3	
Swarthmore College, Swarthmore, Pa.	2	Carl Barus
*Syracuse University, Syracuse, N. Y.	1	
Tennessee, University of, Knoxville	4	W. O. Leffell
*Texas, A & M College of, College Station	7	N. F. Rode
*Texas Technological College, Lubbock	7	T. B. Stenis
*Texas, University of, Austin, and Texas Western College Sub-Branch, El Paso	7	W. J. McKune
*Toledo, University of, Toledo, Ohio	2	Tsute Yang
Toronto, University of, Toronto, Ont., Canada	10	J. E. Reid
*Tufts College, Medford, Mass.	1	Edward Maskenko
*Tulane University, New Orleans, La.	4	J. A. Cronvich
Union College, Schenectady, N. Y.	1	O. G. Owens
United States Naval Academy, Annapolis, Md.	2	D. G. Howard
*Utah, University of, Salt Lake City	9	R. E. Stephenson
Vanderbilt University, Nashville, Tenn.	4	Walter Criley
Vermont, University of, Burlington	1	
*Villanova College, Villanova, Pa.	2	J. B. Clothier, Jr.
Virginia Military Institute, Lexington	4	L. L. Nichols, Jr.
*Virginia Polytechnic Institute, Blacksburg	4	Claudius Lee
*Virginia, University of, Charlottesville	4	C. M. Siegel
Washington, State College of, Pullman	9	O. E. Osburn
*Washington, University of, Seattle	9	F. D. Robbins
Washington University, St. Louis, Mo.	7	R. E. Horn
*Wayne University, Detroit, Mich.	5	E. L. Fairchild
*West Virginia University, Morgantown	2	E. C. Dubbe
*Wisconsin, University of, Madison	5	V. C. Rideout
*Worcester Polytechnic Institute, Worcester, Mass.	1	J. E. Mulligan
*Wyoming, University of, Laramie	6	R. K. Beach
*Yale University, New Haven, Conn.	1	R. R. Shank
Total Branches 135		

*Joint AIEE-IRE Branches 87

1953–1954 AIEE General and District Meetings

1953 Pacific General Meeting
September 1–4, Vancouver, B. C.
J. H. Steede, General Chairman

1953 Middle Eastern District Meeting
Sept. 29–Oct. 1, Charleston, W. Va.
R. H. Greame, General Chairman

1953 Fall General Meeting
November 2–6, Kansas City, Mo.
C. G. Roush, General Chairman

1954 Winter General Meeting
January 18–22, New York City
C. T. Hatcher, General Chairman

1954 Northeastern District Meeting
May 5–7, Schenectady, N. Y.
D. E. Garr, General Chairman

1954 Summer and Pacific General Meeting
June 21–25, Los Angeles, Calif.
Bradley Cozzens, General Chairman

1954 Middle Eastern District Meeting
October 5–7, Reading, Pa.
W. B. Morton, General Chairman

1954 Fall General Meeting
October 11–15, Chicago, Ill.
J. F. Calvert, General Chairman

OF CURRENT INTEREST

Possibilities of Electronic Control of Automobiles Explored by Dr. Zworykin

An exploration of how electronics can be put to work to reduce highway disasters and to relieve drivers of tiresome tasks on modern superhighways has been initiated by Dr. V. K. Zworykin (F '45), Radio Corporation of America (RCA).

Recent electronic advances indicate that electronic aids to many automobile driving problems are approaching the realm of practical application, according to Dr. Zworykin. Although the day of completely automatic control of automobiles is far off, Dr. Zworykin said, certain electronic devices to assist drivers in such matters as bad weather steering and collision prevention are nearer at hand.

To study the basic problems of automatic driving, Dr. Zworykin and assistants at the David Sarnoff Research Center of RCA, in Princeton, N. J., have equipped a model 5-foot car with electronic equipment. This laboratory car, which is powered by a storage battery, can: (1) Steer itself along a prescribed route; (2) Stop itself when approaching a metal obstruction; and (3) Turn out of its original lane into a second lane as if to pass another car moving at a slower speed.

In the laboratory setup, the model car is guided by a wire which represents a cable that would be laid in the roadbed of a superhighway. The wire sets up a magnetic field of a certain frequency which is picked up by the two coils, one on each side of the car. If one coil receives more of the signal than the other it means the car is no longer centered over the wire and electronic equipment controlling the steering wheel immediately brings the car back "on course."

To prevent a collision with an obstruction, simple transistor circuits associated with the guidance wire send out warning signals of another frequency whenever an obstruction passes or is stalled over them. These warning circuits, in effect, produce a "radio tail" at the rear of any sizable metal obstruction on the route. When equipment in the model car receives the warning signal, the brakes are applied automatically and the car comes to a halt.

To simulate two lanes in the same direction, Dr. Zworykin has parallel guidance wires with a diagonal wire connecting them. When the model car senses the radio tail of an obstruction in the inner lane, its electronic equipment shunts it along the diagonal into the outer lane so as to pass the obstruction.

A system of warning circuits in the roadbed to produce a "radio tail" when an automobile passes over would be quite impractical with electron tubes, Dr. Zworykin pointed out. But when transistors are available in large quantity at low cost, he said, such circuits become feasible because power consumption would be reduced.

"The basic requirements of an automatic driving system harmonize with trends in modern highway construction," Dr. Zworykin declared. "The requirements are that the roads have at least two lanes in each direction and that crossings and left turns across traffic be eliminated by cloverleafs and similar systems. With these conditions satisfied, the stage is set for a gradual introduction of measures to reduce traffic risks and simplify driving procedures.

"The changes should necessitate neither sudden abandonment of established driving habits nor wholesale installation of new equipment on roads and vehicles. This means: (1) The driver must retain the freedom of choice of speed, within prescribed limits, and of choice of either manual or automatic control. (2) Automatic control systems must be restricted, initially at least, to high-speed long-distance road systems subject to special regulation, such as turnpikes and throughways. (3) Vehicles equipped with automatic driving devices must be able to benefit in mixed traffic, consisting of equipped and unequipped vehicles.

"As a first step, equipment should be provided to enable the driver to keep his vehicle centered on the traffic lane under conditions of fog and poor visibility in general. This may be accomplished by a cable, buried in the concrete, carrying moderate-frequency alternating currents (of the order of 100 kc) and a pair of magnetic pickups mounted on the car. The difference in the signals derived from the two pickups may be used either to indicate the off-course position of the vehicle on the dashboard or applied directly to the steering mechanism so as to maintain the car in the center of the lane. Feedpoints for the cable may be provided at intervals along the highway.

"In this system the driver not only would retain complete control of the car speed, but, in addition, could switch at will from manual to automatic steering. The automatic setting could be linked to an external indication on the car to inform road supervisors and other drivers of the fact that the car is under automatic control.

"The second step in the evolution of the automatic driving system, the prevention of collisions, is an extension of the equipment.

Future Meetings of Other Societies

American Chemical Society. 124th National Meeting. September 6–11, 1953, Chicago, Ill.

Canadian Electrical Manufacturers Association. 9th Annual Meeting. September 23–25, 1953, General Brock Hotel, Niagara Falls, Ontario, Canada

Conference on Industrial Hydraulics. 9th National Conference. October 8–9, 1953, Hotel Sheraton, Chicago, Ill.

Eastern Electrical Wholesalers Association. 2d National Electrical Industries Show. September 29–October 1, 1953, 69th Regiment Armory, New York, N. Y.

Electric League of Western Pennsylvania. 4th Industrial Electric Exposition. October 6–8, 1953, William Penn Hotel, Pittsburgh, Pa.

Electrochemical Society. September 13–16, 1953, Ocean Terrace Hotel, Wrightsville, N. C.

Engineers' Council for Professional Development. Annual Meeting. October 15–17, 1953, Hotel Statler, New York, N. Y.

Illuminating Engineering Society. National Technical Conference. September 14–18, 1953, Hotel Commodore, New York, N. Y.

Institute of the Aeronautical Sciences and Royal Aeronautical Society. 4th International Aeronautical Conference. September 7–17, 1953, London, England

Instrument Society of America. 8th National Instrument Conference. September 21–25, 1953, Hotel Sherman, Chicago, Ill.

International Association of Electrical Inspectors. 25th Jubilee Meeting. September 21–26, 1953, Edgewater Beach Hotel, Chicago, Ill.

International Hearing Aid Association. 1st International Hearing Aid Show and 5th Annual Convention. September 25–27, 1953, Hotel Commodore, New York, N. Y.

National Association of Corrosion Engineers. South Central Region Meeting. October 7–9, 1953, Mayo Hotel, Tulsa, Okla.

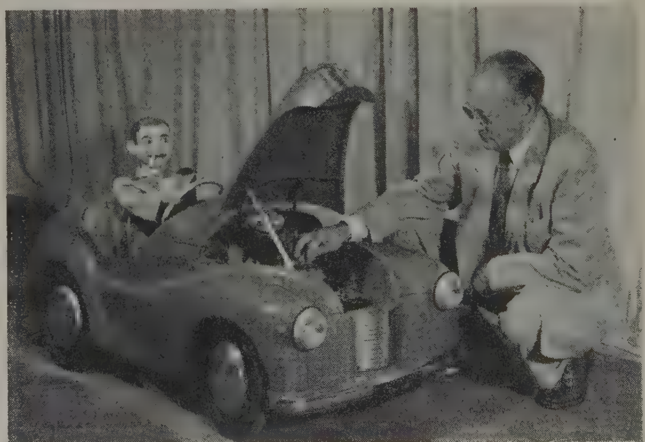
National Electronics Conference. 9th Annual Conference. September 28–30, 1953, Hotel Sherman, Chicago, Ill.

Pennsylvania Electric Association. Annual Meeting. September 22–23, 1953, Benjamin Franklin Hotel, Philadelphia, Pa.

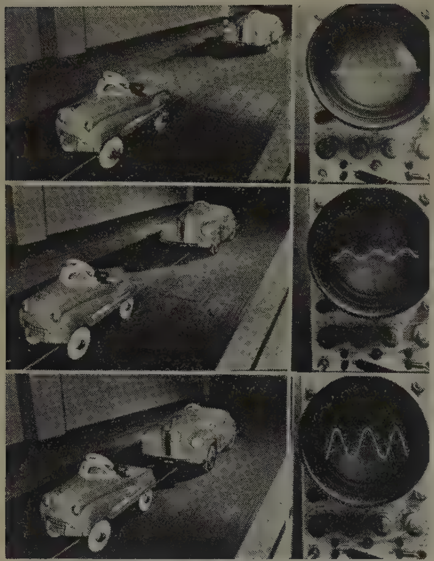
Society of Automotive Engineers. National Aeronautic Meeting, Aircraft Engineering Display, and Aircraft Production Forum. September 29–October 3, 1953, Hotel Statler, Los Angeles, Calif.

Society of Automotive Engineers. National Tractor Meeting and Production Forum. September 14–17, 1953, Hotel Schroeder, Milwaukee, Wis.

The American Society of Mechanical Engineers. Fall Meeting. October 5–7, 1953, Sheraton Hotel, Rochester, N. Y.



Dr. V. K. Zworykin examines electronic apparatus of model car. The experimental car keeps itself centered over the wire which radiates a signal



Model car equipped with experimental electronic equipment is shown stopping itself to prevent a collision. The warning signal is set off by the metal of the parked car in front. Oscilloscope pattern at right of each picture shows how the warning signal received in the rear car gets stronger as it nears danger point

"The essential feature of one proposed collision-prevention system is the transfer of energy from a high-frequency power cable, to a series of tiny oscillators or transmitters along the lane. The transfer of energy is controlled by the passage of a car and a long time constant circuit or 'memory' causes the transmitter to function for a time after the car has passed. The oscillations are transmitted backward along a high-attenuation cable and sensed by pickup coils on the following cars. Thus every car, whether equipped with automatic driving devices or not, would be followed by a 'flying tail' of warning signals. Their amplitude would increase as the car slowed down and become a maximum for a stalled car. Conversely, the sensing system of the following cars would be coupled with the car speed indication so that the warning signal would increase with their speed.

"In a completely automatic system this warning 'tail' could be used to switch a car from one lane to another at specified cross-over points. In this case, the sequence of events as a car approaches another vehicle which is either stalled or moving at a lower speed is: As the signal picked up from the 'flying tail' of the preceding vehicle reaches a certain level, the guidance setting would be shifted to the left lane. Then, the car would pass over to the left lane at the next cross-over point and pass the slower vehicle unless: (*a*) The turn-off is blocked by signals from a nearby vehicle which is already in the left lane; or (*b*) The slower vehicle impedes further progress even before the turn-off point is reached.

"In the second instance the signal from the 'flying tail' would continue to increase in intensity; its indication to the driver may be either auditory or visual—in the form of a sound of rising amplitude or a flashing light of increasing frequency, warning him to decelerate or apply the brakes. As an alternative, the signal, from a certain level on, may reduce the fuel intake and, at a still higher level, actuate the power brakes. Again, by a 3-way switch, the driver could be given the choice of unassisted manual control, manual control assisted by instruments indicating his position and the proximity of other vehicles, and of completely automatic guidance and collision prevention."

Research Project Points Out Advantages in Electric Furnace Steelmaking

The coal, steel, and electrical utility industries could make or save many millions of dollars as a result of a 2-year research project just completed by 14 electrical utility companies and Bituminous Coal Research, Inc., the national research agency of the bituminous coal industry.

Approximately 83,000,000 tons, or 89 per cent, of total United States steel is made in open hearths. Most of this is low-carbon steel. The electrical utility industry and the coal industry, knowing that both would benefit materially if electric furnaces replaced open hearths, joined forces to conduct a comprehensive technical-economic study to discover whether the electric furnace could compete with the open hearth for this major part of the nation's steel production. Both industries stood to gain stabilization of production at a higher level as well as increased sale of their product.

Three plant sizes were studied—250,000 tons, 500,000 tons, and 1,000,000 tons of annual steel production.

They discovered that replacing open-hearth furnaces by electric furnaces could (1) decrease the cost of making low-carbon steel from cold metal up to $3.15 per ton, (2) increase the national output of electricity by 12 per cent, and (3) increase coal production about 25,000,000 tons a year. The latter two estimates assume a total replacement of the existing 950 open-hearth furnaces by 760 electric furnaces.

Open hearths are fired primarily with oil; electric furnaces operate on power usually generated from coal. Future changes in costs of fuels and metals used by the electric furnace and the open hearth are expected to favor the electric furnace.

Manufacturers who supply or service the coal, electrical, and steel industries also stand to increase sales by many millions of dollars. For example, the 25,000,000 tons of coal needed annually for generating the additional electricity would mean $25,000,000 worth of mining equipment. This tonnage means millions of dollars in freight revenue to the railroads and other transportation companies. Supplying power for the electric furnaces for the maximum potential steel tonnage would mean installation of 19,000,000 kw of additional capacity. To build and equip these power generation facilities would take an investment of $3,000,000,000, not including transmission. The electric furnace installations would mean over a billion dollars in sales to manufacturers of furnaces and auxiliary equipment.

Even a 10-per-cent switch to electric furnaces in the near future holds tremendous importance to the industries concerned. Almost 7,000,000 tons of alloy and low-carbon steels were made in electric furnaces last year.

Up to the present, electric furnaces have been used primarily for the production of special alloy steels. During World War II, electric furnace steelmaking expanded to supply increased demands for high-quality steels. At the end of the war, demands for these steels declined and excess electric furnace capacity led some manufacturers to experiment in using this equipment to manufacture low-carbon steel. About the same time, important developments and improvements in equipment, such as the swing roof, high rates of energy input, and increase in furnace size, took place. These improvements reduced charging time, decreased melting time, and lowered current consumption. As a result, important economies were achieved which brought electric furnace steelmaking costs to the level of the open-hearth process.

The comprehensive evaluation just completed proved what had been indicated by the isolated experiments of individual steel companies who used the electric furnace to make low-carbon steel.

The research was conducted by Battelle Memorial Institute for the electrical utility companies and Bituminous Coal Research, Inc. The findings have been published. The 80-page report shows that capital cost for electric furnace installations is only 60 per cent of the cost of open hearths; that the cold-melt steelmaking process using scrap and pig iron shows lower cost for the electric furnace; and that electric furnaces show a greater annual return on invested capital. For the 50-per-cent hot-metal, 50-per-cent scrap-metal process, annual return on invested capital with the electric furnace is equal to or greater than the open hearth. The study and report were based on full capacity operation. Less than full capacity operation would tend to favor the electric furnace becaused fixed costs are lower.

Only the most modern open-hearth installations were used for the study. No plant more than 8 years old was included. Costs shown for open-hearth operation are the lowest which have been achieved or which the steel industry considers to be possible. For the electric furnace, costs have been used which are conservative and beyond challenge. Three representatives of the steel industry advised on the collection of data and preparation of the final report.

In addition to reduced capital investment, and reduced cost of steel production in cold-melt practice, the electric furnace offers steel company management other important advantages over the open hearth.

The electric furnace is more flexible. It can be put into production or withdrawn at will while the open hearth must be fired when idle in order to protect the brick work.

Electric furnaces can be kept in operation all but about 15 days a year while open hearths are usually down about 30 days. Rebuilding time is shorter for the electric furnace.

The yield of the electric furnace is about 2 per cent greater than the open hearth for the same amount of materials.

The electric furnace gives greater control of sulphur in the production of deep drawing sheets and welding grades of steel.

Because of its better temperature control the electric furnace saves time in steel production. Nitrogen control by the electric furnace is expected to match that of the open hearth.

This report contains detailed tables showing not only costs, but also operating data, pounds, gallons, man-hours, so steel companies readily can apply their own operating and cost data to evaluate electric furnaces versus open hearths for their own plants. It can be obtained at $10.00 per copy from Bituminous Coal Research, Inc., 2609 First National Bank Building, Pittsburgh 22, Pa.

Liversidge to Speak at ECPD Annual Meeting

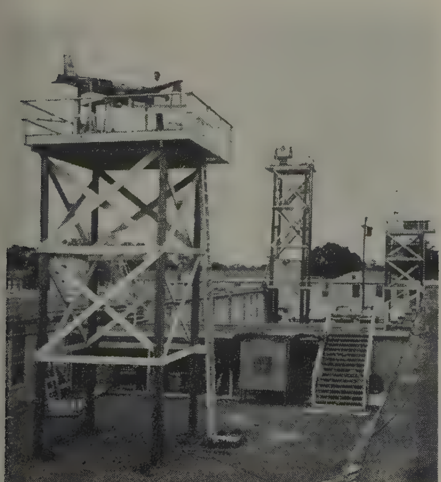
Horace P. Liversidge, chairman of the board, Philadelphia (Pa.) Electric Company, will address the annual meeting of Engineers' Council for Professional Development in New York, N. Y., October 15–17, 1953. The Engineering College Research Council and the Engineering College Administrative Council of the American Society for Engineering Education will also meet in New York, October 14–15.

Mr. Liversidge will speak at the annual engineers dinner on October 16. His topic will be "Industry and Engineering Education." (The complete program for the meetings will appear in the October issue.)

Stanford Research Institute Reorganizes Laboratory

The Engineering Division of Stanford Research Institute has revised and expanded the organization of its well-known Aircraft Radiation Systems Laboratory.

Thomas H. Morrin, director of Engineering Research, has announced that expansion of industrial services in aircraft and communications programs has necessitated regrouping of related technical sections under a Radio Systems Laboratory, by which name the new arrangement will be known.



The Radio Systems Laboratory rooftop and tower installations make up an antenna pattern test range

Mr. Morrin has announced further that the broadened scope of research and development in the areas of radio communications at the institute has made it desirable to change the name of the Single Sideband Communications Group to the Communications Group. Formerly a separate research section, the Communications Group henceforth will be a part of the Radio Systems Laboratory.

Heading the new structure will be Dr. J. V. N. Granger, assistant chairman of the Engineering Department. Assistant head is Dr. John T. Bolljahn.

Technical groups now assigned to the Radio Systems Laboratory are: communications; antenna research; antenna development; air-borne applications; and microwave.

Mr. Morrin has emphasized that the revamped organization indicates no reduction in the scope of work for the aircraft industry. The laboratory is prepared to undertake systems work of all types, including studies of aircraft communications, performance requirements, and performance evaluation.

Radio equipment development will continue on flush antennas, multiplexing devices, navigational aids, and communication equipment.

The Microwave Group has facilities for radar antenna development, radome studies, and research on microwave components.

The Communications Group, which has spent more than 4 years on single-sideband transmission for military applications, is working on an air-borne single-sideband program. Future studies will involve reduction in equipment size and the economics of air-borne applications.

Voice Communication System Developed for Industrial Use

A 2-way voice communication system for industrial use, linking "base stations" with mobile units such as cranes, ore bridges, yard locomotives, and boat unloaders is a new development of Mine Safety Appliances Company.

The "telecrane" frequency-modulated carrier communication system helps co-ordinate operations by speeding production, promoting safety, and reducing delays in materials handling.

Clear, direct voice communication, audible above the noise level of plant operations, is achieved with this heavy-duty system. It is free from transmission noise.

No new or additional wiring connections are needed; it employs existing electric circuits for transmitting carrier waves. A coupling capacitor joins the carrier frequency to any a-c or d-c power line. For isolated locations, circuits which operate on storage batteries are available.

The compactly designed Telecrane transmitter-receiver unit is tray-mounted to facilitate servicing. The extension microphone, used in cranes and mobile equipment, is adjustable to any desired position, and a heavy-duty foot switch keys the transmitter or closes the speaker circuit, leaving the operator's hands free.

Foreman employs the new Telecrane communication system to direct crane operator (left background) handling ingots at the soaking pits. Telecrane transmitter is wall-mounted to foreman's left, speaker at right, at this base station; in the crane the equipment box and transformer are conveniently located in the cab

At the base station or permanently located units the operator need only depress a lever to talk, release it to listen. Each speaker has its own volume control so that it may be adjusted in relation to surrounding conditions. The loudspeaker has impedance-matching transformer which can be used with one to three speakers. An audio amplifier may be used if more than three speakers are desired off the same base equipment.

The equipment box houses the transmitter-receiver unit, filter unit, terminal block, and power circuit resistors.

National Officers Elected by Eta Kappa Nu for 1953–54

E. T. B. Gross (F '48), professor of power systems engineering, Illinois Institute of Technology, Chicago, has been elected national president of Eta Kappa Nu, electrical engineering honor society, for 1953–54.

J. E. Hobson (F '48), director, Stanford (Calif.) Research Institute, was elected national vice-president, and A. B. Zerby (AM '38) was re-elected national secretary.

Members of the national Advisory Board are O. W. Eshbach (F '37), dean, Northwestern Technological Institute, Chicago, Ill.; F. J. Hallenback (AM '40), member of technical staff, Bell Telephone Laboratories, Inc., Murray Hill, N. J.; C. T. Koerner (AM '35), senior engineer, Pacific Telephone and Telegraph Company, Los Angeles, Calif.; E. B. Kurtz (F '29), professor and head, Department of Electrical Engineering, University of Iowa, Iowa City; Albrecht Naeter (M '30), head, School of Electrical Engineering, Oklahoma Agricultural and Mechanical College, Stillwater; G. W. Swenson (F '36), professor and head, Department of Electrical Engineering, Michigan College of Mining and Technology, Houghton; and S. R. Warren (F '53), professor of electrical engineering, University of Pennsylvania, Philadelphia.

Most Powerful Electric Motors Installed in Wind Tunnel

The most powerful electric motors known to have been built were installed recently at the Arnold Engineering Development Center, Tullahoma, Tenn.

Installation of the motors, which are as high as a 2-story house, is the first major step in the assembly of what is believed to be the world's largest rotating machine. The two motors, rated at 83,000 horsepower each, and a smaller pair, rated at 25,000 horsepower each, will produce a total of 216,000 horsepower to drive five huge compressors which will produce man-made hurricanes for transonic and supersonic wind tunnels of the Propulsion Wind Tunnel Facility at the Arnold Engineering Development Center. This center is the newest of the nine research, development and testing centers of the Air Force's Air Research and Development Command. The center's facilities, now under construction, will provide the nation with the means for testing and evaluating supersonic aircraft, guided missiles, and aircraft engines.

Westinghouse Electric Corporation built the motors at its East Pittsburgh, Pa., plant and is in the process of constructing the compressors at Sunnyvale, Calif. When put together tandem fashion, the entire machine will be 500 feet in length.

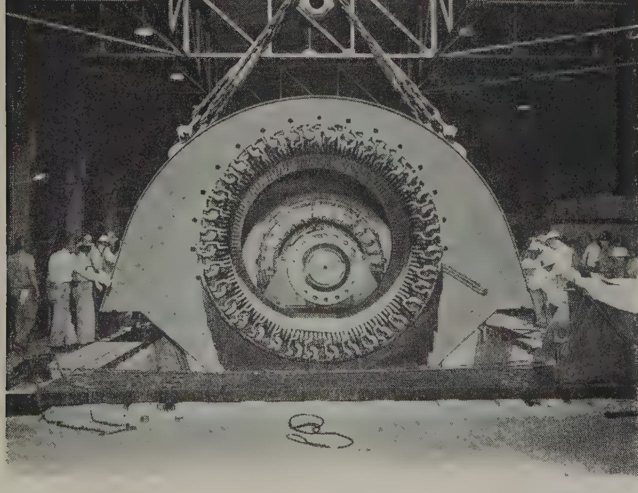
The motors were picked up by a giant overhead crane, which stands nearly 100 feet high, lifted up 70 feet in the air, and lowered through the roof of the motor-drive building into their mountings.

Though the machine will represent the highest stored energy of any rotating mass ever built, it will be brought to a halt in about 3 minutes time by using its wound-rotor motors as brakes. The energy is dumped into liquid rheostats, which are used for secondary control.

The five compressors now under construction at Sunnyvale are not expected to be completed for at least another year. The transonic compressor will be a single unit; but the supersonic compressor, which will push the air through the tunnels at speeds above the speed of sound, will be four compressors coupled as one.

The blades for the compressor measure 2 feet across the face, 6 feet in length, and will rotate on a spindle 18 feet in diameter. Weighing almost two-thirds of a ton each the blades will be solid forgings rooted to enormous disks.

A quarter-scale model of one of the multiple-stage compressors has been built. The model underwent exhaustive tests to insure that the outsize blades will not develop excessive vibrations at operating speeds.



A huge 100-ton stator is lowered into its position in the motor drive building of the Air Force's Arnold Engineering Development Center, Tullahoma, Tenn.

U.S. Air Force photo

Jet-Cooled Bushing Developed for Hydrogen-Cooled Generators

A new jet-cooling method of terminal bushing ventilation for its hydrogen-cooled steam turbine-generators has been developed by Allis-Chalmers engineers. The development increases the current capacity of conventional bushings nearly four to one while maintaining a compact, mechanically sturdy conductor and bushing design. It is of particular significance because of the demands made on terminal bushings by the increased ratings which are being built into generators.

To meet these heightened requirements, multiple bushings have been used in some instances to keep bushing temperatures within safe limits at high amperage. Still other machines have been built with bushings of 6,000-ampere capacity and larger. Besides posing problems in design and manufacture, the excessive size of these large bushings makes them difficult to handle and install, and subjects them to operational hazards.

The new jet-cooled terminal bushing utilizes the cooling capabilities of high-velocity hydrogen gas in much the same way as does supercharging of generator conductors. The terminal conductor is a hollow copper stud, divided into inlet and outlet passages by a vertical partition. A jet of cool hydrogen, forced at high velocity from the generator pressure chamber, is directed through a hole in the top of the bushing. It travels through the passages in direct contact with conductor copper and exhausts into the fan suction region of the generator by means of radial openings in the bushing cap.

Tests indicate that with jet-cooling a 4,500-ampere bushing can carry 17,500 amperes safely with hydrogen pressure at 30 pounds per square inch gauge. Even at 0.5-pound-per-square-inch-gauge hydrogen, the bushing will carry well over 10,000 amperes.

While this development in generator design parallels advances in supercharged cooling, it is equally applicable to nonsupercharged hydrogen-cooled machines operating at normal pressures. It makes standard 13,800-volt machines practical in much larger ratings than ever before.

The new jet-cooled bushings will be used for the first time on the 118,450-kw 15,500-volt 1,800-rpm generator now being completed for the low-pressure end of a 156,250-kw cross-compound Allis-Chalmers turbine-generator unit for a midwestern utility.

Training Program Announced in Cobalt 60 Radiography

Early this fall Technical Operations, will offer the first in a series of 2-week training programs in Cobalt 60 radiography in industry. This program will cover health physics, the handling of Cobalt 60 and other gamma sources, and the practical and theoretical aspects of industrial radiography.

Approximately half the time will be taken in lectures, demonstrations, and question and answer periods, the rest being devoted to actual practice, including experiments in shielding, radiation measurement, and the taking of radiographs.

Applicants should have previous technical training and/or experience in some field related to foundry practice, steel fabrication, mechanical engineering, or radiography.

The program has the supplemental purpose of providing the basis for approval by the Atomic Energy Commission for purchase of Cobalt 60.

Enrollment will be limited. For further details, write Technical Operations, Incorporated, 6 Schouler Court, Arlington 74, Mass.

Instrument Maintenance Clinic to Be Held Before Conference

The Fifth Preconference Instrument Society of America (ISA) Instrument Maintenance Clinic will be operated during September 18, 19, and 20, the 3 days prior to the opening of the Eighth National Instrument Conference and Exhibit to be held in Chicago, Ill., September 21–25, 1953.

The Clinic program will include the following subjects: pyrometers, millivoltmeter type; electric instruments; mechanical and electric potentiometers; electronic potentiometers; graphic panel instruments; control valve selection and maintenance; combustion control; oxygen recorder; flow meters, electric type; liquid level control and control valves; area-type flow meters; and self-operated controls.

Classes will begin on Friday, September 18, at 1:00 p.m. There will be a total of nine 2-hour sessions, three each on Friday, Saturday, and Sunday. Friday evening will be devoted to a general session on "Principles of Instrumentation and Automatic Control."

This Clinic will be held in the various classrooms set up in the Morrison Hotel.

The Clinic is open to members of the ISA, The American Society of Mechanical Engineers, AIEE, and Institute of Radio Engineers without charge. Nonmembers may attend to the extent of available space after registration of members. Nonmembers wil

be charged a $3.00 registration fee which must accompany application.

Prior registration is required by those desiring to attend the Maintenance Clinic. Registration will close September 14. All those planning to attend are urged to register now with the National Office of ISA, 1319 Allegheny Avenue, Pittsburgh 33, Pa.

Ohio Valley Electric Places Largest Single Bond Issue

Details of a $420,000,000 negotiated financing operation, including the largest direct placement of a single issue of securities in the history of the utility business, were announced recently. This amount is the major portion of the estimated maximum capital requirements of $440,000,000, all undertaken by private capital, of the Ohio Valley Electric Corporation.

Ohio Valley, formed by 15 private electrical utility companies to supply the huge power requirements of the United States Atomic Energy Commission's new atomic diffusion plant near Portsmouth, Ohio, has arranged the sale of $360,000,000 of $3^3/_4$ per cent First Mortgage and Collateral Trust Bonds, due January 1, 1982, to be delivered in installments until January 1, 1957. Negotiated by The First Boston Corporation, the sale was made to 29 insurance companies, seven pension funds, and two savings banks.

The sale of $60,000,000 Notes, bearing 4 per cent and maturing January 1, 1967, was arranged through The First National Bank of the City of New York, acting as agent for a group of 12 banks and two pension funds.

Equity capital of $20,000,000, which makes up the balance of Ohio Valley's estimated maximum capital requirements, will be supplied by the 15 sponsoring electrical utility companies or the parents of some of them.

Scientific Personnel Program May Benefit Army Inductees

The United States Army Scientific and Professional Personnel Program should be of special interest to recent engineering graduates who will be inducted shortly into the Armed Forces because it was designed to channel as many such persons as possible into Army billets which will insure the maximum utilization of their engineering or scientific training and experience for their own continued professional development and for the advancement of the Army's technical programs. The program is described in detail in Department of the Army Special Regulation *615-25-11*, dated August 7, 1952.

The regulations provide for the identification, classification, assignment, and utilization of those persons who are qualified to perform scientific and professional level duties in research and development, instruction, and related work of professional or scientific nature.

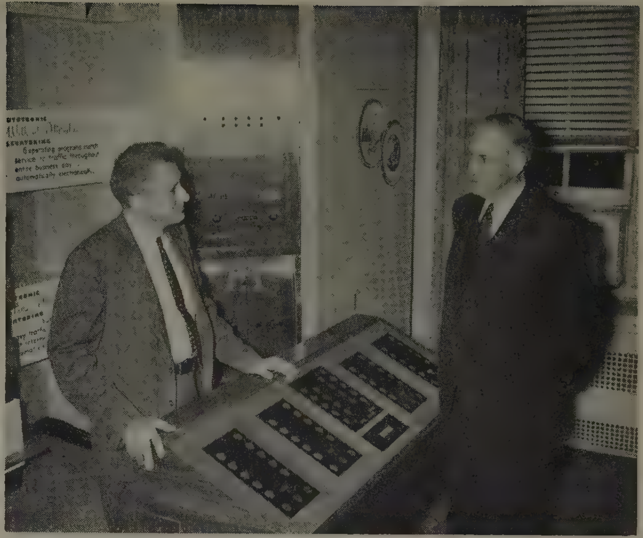
Commanders of reception centers and other installations conducting initial reception processing are responsible for the proper identification and indoctrination of scientific and professional personnel and for their transfer to appropriate basic training.

The regulations concerning the selection of Scientific and Professional Personnel are far too complex for adequate reproduction here. The regulations differ for each major scientific and professional field. In some cases, only a bachelor of science degree is required. In others, a bachelors degree plus a certain amount of experience or an advance degree are required.

Personnel qualified as Scientific and Professional Personnel are assigned a Military Occupational Specialty number which reflects their specialty and is intended to be used as a guide in their assignment to billets in which their training and experience will be utilized. All the major engineering and scientific fields are covered by the regulation although the qualifications differ somewhat.

Copies of the basic regulation are available from the Department of the Army, Washington 25, D. C.

The Engineering Manpower Commission of Engineers Joint Council is very interested in the efficiency of the Scientific and Professional Personnel program. It feels that the dissemination of information regarding the existence of the program is vital to its success and would appreciate information regarding engineers and scientists qualified under the program who are not being utilized in their fields of special qualification.



LeRoy A. Petersen (right), president of Otis Elevator Company, and William H. Bruns (left), supervisor of engineering research, set up an elevator traffic problem for automatic solution by the new electronic traffic analyzer

Electronic "Brain" Provides Automatic Elevator Service

An electronic "brain" that makes elevator service in busy buildings completely automatic was demonstrated for the first time recently by the Otis Elevator Company. The electronic traffic analyzer and automatic program selector demonstrated are similar to elevator control equipment now being installed in new and modernized buildings. In the demonstration, the "brain" controlled the operation of a model in which flashing lights simulated the movements of a 4-car bank of elevators in a 10-story building.

Automatic program selection culminates engineering development that has been making elevator service progressively less dependent on the human element. Automatic supervisory systems already in use co-ordinate the operation of a bank of elevators according to any one of several dispatching programs. But even with automatic group supervision, the elevator starter had to watch lobby traffic and the changing pattern of lights on his indicator panel, decide which dispatching program and interval best would handle the prevailing traffic, and switch the supervisory system to the desired settings.

Now, with automatic program selection, the traffic analyzer continually records passenger calls and waiting time data, and the program selector automatically puts into effect the appropriate dispatching program and interval. When the traffic pattern changes, the control system promptly adjusts elevator service accordingly.

The system anticipates the morning and evening rush by putting into effect the UP-peak or DOWN-peak program, respectively. The peak program stays in effect for the duration of the rush period. At all other times, the traffic itself determines which program is in effect. Automatic program selection frees the starter of all responsibility for elevator supervision. He can devote his full time to giving information and providing the other personal services that tenants and visitors expect.

Circuit connections of the electronic touch buttons on the console of the Otis demonstrator correspond to those of the numbered buttons in elevator cars and the "UP" and "DOWN" buttons at landings in an actual building. By touching the proper buttons on the demonstrator console, engineers are able to simulate the various traffic conditions that occur in a real building, and watch how the model elevator system, under control of the electronic brain, handles each situation as it arises.

Aside from its value in demonstrating automatic program selection, the model also will be used by Otis engineers to investigate special traffic-handling problems.

Otis engineers have been extending the application of electronic analyzer and automatic changeover principles to respond to variations in traffic and elevator performance at all times. The result is automatic program selection, which puts into effect any one of the six Autotronic dispatching programs as determined by the prevailing traffic pattern. Together with modifications of the elevator system for fully automatic "operatorless" service, automatic program selection enables the entire Autotronic elevator system to "think for itself" without human intervention.

Electrical Industries Show to Stress Adequate Wiring

Adequate wiring in homes and business premises will be the theme of the Second National Electrical Industries Show, sponsored by the Eastern Electrical Wholesalers Association, which will be held September 29–October 2, 1953, in New York, N. Y.

Stressing "Safety Through Adequate Wiring," the show will launch a nation-wide educational drive to bring all phases of the electrical industry, including manufacturers, wholesalers, distributors, contractors, architects, engineers, builders, purchasing agents, and utility companies into a program aimed at promoting modernization of wiring systems.

The need for such a program was pointed out in a recent statement by the show's directors, Harold R. Meyer and William S. Orkin, who cited the latest available figures for the nation's annual fire losses. The figures disclosed, they said, that fire destroyed $730,084,000 worth of property in 1951, and rose to losses in excess of $815,134,000 in 1952. Based on past statistics, they said, approximately 12 per cent of these totals could be attributed to fire resulting from electricity and electric power-consuming devices.

LETTERS TO THE EDITOR

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers. Publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.

Electrostatic Safety

To the Editor:

The writer appreciates the illuminating letter to the editor from F. L. Hermach (*EE, Jul '53, pp 664–5*) wherein he sets forth principles and indicates test data used in the formulation of certain recommendations in the National Fire Protection Association (NFPA) Bulletin *56*.

Mr. Hermach's concluding paragraph, relating to my article, "Electrostatic Safety for Hospital Operating Rooms," (*EE, Apr '53, pp 329–34*) states that differences between the NFPA recommendations and the writer's opinions can be readily resolved. A complete array of facts and fundamental principles are the chessmen which disagreeing engineers basically manipulate in resolving differences of opinion. Although the area of subject matter included in Mr. Hermach's letter seems too extensive and our dissenting opinions too diverse for resolution through these brief columns, the writer will offer here only a few comments, some in concurrence and some in rebuttal of those by Mr. Hermach.

The writer concurs with the general principle stated in the second paragraph of Mr. Hermach's letter to the effect that the safe upper resistance limit for flooring should be low enough in megohms to discharge the static electricity practically as fast as it generates in order to prevent any rises of voltage to the spark-ignition threshold. This resistance value is determined by the capacitance and the time constant of the particular electric circuit; and, the principle here stated has been used in the writer's industrial controls of electrostatic hazards for many years.

In addition, the writer agrees without reservation with the principle stated in the third paragraph of Mr. Hermach's letter, a principle which is cited in the writer's article on page 332. Likewise for the fourth paragraph, the writer independently arrived at the safe upper resistance limit as stated in the order of 25 to 50 megohms, although recommending in the afore-mentioned article what he considered an ultra-conservative safe limit of 10 megohms rather than so low a value as the 1 megohm specified by NFPA.

Relative to the fifth paragraph of Mr. Hermach's letter, a simple, positive, controlled-resistance, safety grounding unit regarding which the writer is consulting with the manufacturer removes all the problems of vagarious hazards associated with worthless grounding chains and their inherent sparking potentialities and with high contact resistances of rubber casters, rubber leg tips, and metal gliders on portable facilities used in hospital operating rooms. Hence, by resolving these erratic contact-resistance problems by using this controlled-resistance safety grounding unit, 10 megohms or even more for the safe upper resistance limit for flooring seems indicated, justifiable, and reasonable.

The NFPA committee, by not having prior information available regarding the merits of this safety grounding unit now being developed to eliminate the previous objections of high contact resistances of floor-borne portable equipment as an effective aid to intercoupling, obviously could not have been expected to take cognizance of this improved safety feature.

On this proposed new basis of eliminating the highly erratic contact resistances of all floor-borne equipment, there is now the more reason to determine by simple, direct measurement the actual floor resistance, reducing to inconsequence the normally high contact resistances of the NFPA electrodes, by using on their bare surfaces a suitable coating of conductive paste, as the results of the writer's measurements show in curve *C* of Figure 2 of the article. Much of the discussion in the fifth paragraph, relating to the measurements with NFPA electrodes in view of the foregoing considerations, now may be passed over in the interests of conserving space.

With regard to Mr. Hermach's seventh paragraph, simple arithmetic discloses tha[t] the threshold value of electric shock or arc ignition from a bare, live, 125-volt electri[c] cord or appliance may be controlled by th[e] lower resistance limit in the order of 100,00[0] to 125,000 ohms; hence, double this resistance value of about 250,000 ohms provides [a] suggested safe lower resistance limit. Sinc[e] the resistance of a conductive floor now ca[n] be controlled in its manufacture and installation to reasonably close tolerance, a floo[r] whose resistance lies in the order of 350,00[0] to 500,000 ohms between 3-foot spaced electrodes seems an excellent objective.

Predicated on the afore-mentioned value o[f] median floor resistance and recognizing th[e] inherently hazardous and unnecessary use o[f] wet sheets around the bases of operating tables and anesthesia machines, safety in th[e] operating room from electric shock or arc ignition by faulty cords seems adequatel[y] provided. This being the case, no particula[r] reason is apparent for resorting to the adde[d] cost and maintenance expense of providin[g] special insulating transformers, dual wirin[g] provisions, and troublesome signal systems t[o] operate ungrounded electrical distributio[n] throughout all hazardous areas in hospitals.

Another hazard in operating rooms whic[h] the writer considers a serious source of possible electric shocks, electrocution, and arc ignitions from faulty wires or electric appliances arises from the use of unprotecte[d] radiators, water outlets, and other expose[d] grounded facilities. These hazards seem not to be covered in NFPA Bulletin *56*.

Radiators should be guarded from inadvertent contact by operating-room personne[l] through the use of substantial front covers o[f] glass or insulating barriers, mounted abov[e] the floor sufficiently to provide adequat[e] draft for efficient heating and for convenienc[e] in floor cleaning. The barriers should b[e] continued high enough above the floor t[o] protect personnel from reaching over the[m] and touching a radiator, providing a sma[ll] side opening by which the radiator valv[e] may be controlled as desired.

Water facilities should be confined to adjoining sterilizing rooms, using hose connections into the operating rooms when and [if] necessary. A half-inch rubber or plasti[c] hose, 25 feet long, supplied with tap water possesses excellent high-resistance properties the resistance between the ends of the hos[e] varying from about 1 megohm under stati[c] water-filled hose conditions to over 1[…] megohms under full-flow velocity.

ROBIN BEACH (F '3[…])
(Robin Beach Engineers Associated, Brooklyn, N. Y.)

Nomograph for Coil Calculations

To the Editor:

In a letter to the editor (*EE, Jul '53, p 664*[…]) C. P. Nachod refers to my recent char[t] "Design Chart for a Single-Layer Air-Co[re] Transformer" (*EE, Mar '53, pp 248–9*). [I] wish to thank Mr. Nachod for drawing m[y] attention to his nomograph for coil calculations which appeared in the January 193[…] issue of *Electronics*, page 27. This nomograp[h] could be used as an alternative to either [of] the two references which are given as footnotes in my article. To avoid any confusio[n] it should be pointed out that his nomograp[h] does not treat the same problem that [...]

covered by my chart. Mine refers to a transformer or tapped coil and not to a simple solenoid. My Figure 1 would have been a little clearer had I shown either three or four external connections to the coil.

I should like to take this opportunity to ask the readers of *Electrical Engineering* if they have seen any formula or chart in the literature permitting the design of a tapped solenoid without trial and error. (It is hardly necessary to point out that there is a difference between a long thin coil, tapped at, say, one-third of its length and a second coil with the same inductance and tap position, but with a smaller length: diameter ratio.)

A. C. HUDSON (AM '45)

(National Research Council, Ottawa, Ontario, Canada)

International Radio Communications

To the Editor:

I refer to my paper, "The First 50 Years of International Radio Communication," which I presented at Chicago, Ill., last year and which was published in the AIEE bimonthly publication, *Communication and Electronics* (*Nov '52, pp 371–5*).

Dr. Edwin H. Armstrong has written me calling attention to my statement that, following the invention of the 3-element vacuum tube in 1906, "for many years the device was confined to the detection and amplification of radio signals, but about 1912 it was discovered, and so forth." Dr. Armstrong is correct in pointing out that it could be concluded erroneously from this that the amplifying characteristics of the tube were known during the entire period from 1906, whereas, factually, the first public knowledge on this subject in the United States appeared in 1912. It subsequently developed, however, that Lowenstein (in the United States) ascertained in 1911 that the 3-element audion could be used as an amplifier of audio-frequency currents and Von Lieben and Reisz (in Germany) became aware of such potentialities, also in 1911.

Dr. Armstrong also commented on the statement in my paper: "The vacuum tube was responsible for another epoch which started soon after 1920 when it was found by radio amateur enthusiasts that waves shorter than 100 meters could be used over long distances." He pointed out that Captain Round, working with Marconi, and using waves 100 meters long, discovered these long-distance phenomena in 1920 which was the year before the amateurs transmitted 200-meter wave signals across the Atlantic. However, the basic and important discovery that these short waves could traverse great distances during hours of daylight was first made 4 years later in 1924, by Marconi, using waves 32 meters long.

HARADEN PRATT (F '37)

(Telecommunications Advisor, Excutive Office of the President, Washington, D. C.)

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NEW BOOKS • • • • •

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

ANNUAL REVIEW OF NUCLEAR SCIENCE. Volume II, 1953. Annual Reviews, Inc., Stanford, Calif., 1953. 429 pages, 9 by 6¼ inches, bound. $6. The 16 papers contained in this volume cover a considerable range of topics, including the following: origin and distribution of the elements, production and distribution of natural radiocarbon, recent progress in accelerators, nuclear and photonuclear reactions, subnuclear particles, radiation effects in solids, isotopes, nuclear moments, cosmic rays, and high-energy fission.

THE DESIGN OF ELECTRONIC MEASURING INSTRUMENTS. By F. G. Spreadbury. Association of Engineering and Shipbuilding Draughtsmen, Richmond, Surrey, England, 1953. 102 pages, 8¼ by 5½ inches, paper. 4s. Attention is directed in this pamphlet to the design of basic instrument types—the cathode-ray oscillograph, voltmeters, ammeters, wattmeters, the frequency meter, the chronometer, and others. Tube characteristics relative to instrument design and the stabilization of power supplies are discussed, and a number of actual instruments are described. A brief list of references is appended.

ENGINEERS AS WRITERS. Edited by Walter J. Miller and Leo E. A. Saidla. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York 3, N. Y., 1953. 340 pages, 8¾ by 5¾ in., bound. $4.25. A text for instruction in technical composition, presenting selections from the works of 15 engineering writers of different periods and fields. Each selection is followed by a critical analysis, suggestions for study, and topics for oral or written reports. The selections—running from Vitruvius and Agricola to Taylor and Hoover—are, for the most part, suitable for students in any field of engineering, and readily understandable to the layman. A few highly specialized writings are included.

EQUIVALENT RADIO TUBES VADE-MECUM. P. H. Brans, Ltd., Antwerp, Belgium (distributed in United States by Editors and Engineers Ltd., Box 689, Santa Barbara, Calif.), tenth edition, 1953. 303 pages, 11½ by 8 inches, bound. $5. The present extensive range of tube data has necessitated spreading the material over three editions as follows: 9th edition (previously issued)—radio tube characteristics; 10th edition (the one reviewed here)—a guide reference for the possible exchanges or substitutions of radio tubes, indicating direct or near equivalents for both simple and complex cases, with specialized information as to differences, and covering military tubes as well as commercial types; 11th edition (to be issued next year)—television and special tube characteristics.

FLUID DYNAMICS. (Proceedings of Symposia in Applied Mathematics, Volume IV.) American Mathematical Society. McGraw-Hill Book Company, Inc., 330 West 42d Street, New York 36, N. Y., 1953. 186 pages, 10¼ by 7 inches, bound. $7. Fourteen papers by recognized authorities are presented which provide, among other topics, significant contributions on the statistical theory of turbulence and the mathematical theory of supersonic and transonic flow. The subject of incompressible flow is represented by articles on propeller theory, numerical methods, viscous flow, and the method of singularities. There are also treatments of shock waves and gravity waves.

THE GREEN LEAF GUIDE. National Reference Guide for the Patent Field. Field Publications, Port Washington, N. Y., 1953 edition. 64 pages, 9 by 6 inches, paper. $2. This guide contains broadly classified listings of leading manufacturers in every important industrial field and companies which are actively seeking new ideas of many different kinds. It also contains a brief list of services for inventors and patent attorneys and notes on government publications relating to patents.

HISTORY OF STRENGTH OF MATERIALS. By Stephen P. Timoshenko. McGraw-Hill Book Company, Inc., 330 West 42d Street, New York 36, N. Y., 1953. 452 pages, 9¼ by 6¼ inches, bound. $10. Based on Professor Timoshenko's lectures on engineering mechanics, this book traces the development of the science of strength of materials from Archimedes to the present. Brief biographies of workers in the field are included; and the relation of progress in the science to industrial development and engineering education is considered. Some discussion of the history of the theory of elasticity and the theory of structures is also included.

INTRODUCTION TO THE THEORY OF PLASTICITY FOR ENGINEERS. By Oscar Hoffman and George Sachs. McGraw-Hill Book Company, Inc., 330 West 42d Street, New York 36, N. Y., 1953. 276 pages, 9¼ by 6¼ inches, bound. $6.50. This text deals with that comparatively recent branch of mechanics which treats the behavior of ductile metals beyond the elastic range. It not only introduces the fundamentals, but also gives accounts of all major engineering applications of the theory of plasticity. The several sections are as follows: basic laws and theories; problems in plastic flow of ideally plastic materials; plastic flow of strain-hardening materials; theory of metal-forming processes.

MACRAE'S BLUE BOOK, 60th Edition, 1953. MacRae's Blue Book Company, 18 East Huron Street, Chicago 11, Ill., 1953. 4,127 pages, 11 by 8½ inches, bound. $15. This 60th annual edition of one of the standard directories of American manufacturers and their products follows the arrangement of previous editions: a list of industrial manufacturers and their distributors; a detailed classified materials section with cross-references; and a trade name index. Capital ratings are indicated where reliable information has been supplied.

MICROWAVE SPECTROSCOPY. By Walter Gordy, William V. Smith, and Ralph F. Trambarulo. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., 1953. 446 pages, 9¼ by 6¼ inches, bound. $8. This first book in a relatively new field provides a comprehensive statement of the present knowledge of the subject. It describes the types of spectrographs, microwave and electronic components, and measurement methods. It discusses microwave spectra of gases, spectra of solids and liquids, nuclear properties, molecular structures, and applications in other fields. Extensive data tables and a 600-item bibliography are appended.

PHYSICAL FORMULAE. By T. S. E. Thomas. John Wiley and Sons Inc., 440 Fourth Avenue, New York 16, N. Y., 1953. 118 pages, 6¾ by 4½ inches, bound. $2. Intended as a reference book for physicists and engineers, this is a compilation of the principal mathematical laws and formulas arranged in the following subdivisions: mathematics and statistics; mechanics; hydraulics; elasticity; general physics; acoustics and Fourier series; heat; light; electricity and magnetism; and electronic physics. Purely empirical formulas, and those of little practical importance have been omitted.

RADIO ENGINEERING. Volume II. By E. K. Sandeman. Chapman & Hall Ltd., London, England, second edition, 1953. 613 pages, 9 by 6 inches, bound. 55s. A detailed treatment of fundamentals primarily for beginners, but containing a sufficiently extensive amount of technical data to serve as a reference book for the practicing engineer or designer. Important topics in this second volume are interference and noise, receivers, measuring equipment, feedback, network theory, filters, and standard calculations. There is a classified bibliography of some 1,200 references.

TELEVISION RECEIVER DESIGN. Monograph 1: Intermediate-Frequency Stages. By A. G. W. Uitjens. Philips' Technical Library, Eindhoven, Holland (dis-

tributed in United States by Elsevier Press, Lovett Boulevard, Houston 6, Tex.), 1953. 177 pages, $9^1/_4$ by $6^1/_2$ inches, bound. $4.50. The first of a new group within the Philips series on electron tubes, this volume deals with the application of the pentode in the intermediate-frequency section of a superheterodyne receiver and the high-frequency stages of a tuned radio frequency receiver. This volume and the subsequent ones constitute specialized monographs providing detailed consideration of problems encountered in design and practice of television receivers.

THE WRITINGS OF THE GILBRETHS. Edited by William R. Spriegel and Clark E. Myers. Richard D. Irwin, Inc., Homewood, Ill., 1953. 513 pages, $9^1/_4$ by $6^1/_4$ inches, bound. $7.35. This book assembles in a single volume the works of Frank B. and Lillian M. Gilbreth, edited to include evidences of lasting principles and problems, to exclude matter significant only at the time of writing, and to avoid duplication of the works of their contemporaries. The original wording has been retained except for minor changes in spelling and terminology, and changes made in the interest of continuity and readability. The volume includes a combined index to the writings.

ZIRCONIUM AND ZIRCONIUM ALLOYS. American Society for Metals, 7301 Euclid Avenue, Cleveland 3, Ohio, 1953. 354 pages, $9^1/_4$ by $6^1/_4$ inches, bound. $7. The 21 papers comprising this symposium deal with a wide range of topics: zirconium ores and extractive metallurgy processes, preparation of zirconium powder, manufacture of zirconium sponge, fabrication of zirconium, metallographic procedures, corrosion and corrosion resistance. Several papers cover investigations of various zirconium binary systems, with emphasis on phase diagrams. The final paper discusses zirconium with relation to nuclear reactors.

ASTM STANDARDS ON LIGHT METALS AND ALLOYS. Sponsored by ASTM Committee *B-7* on Light Metals, Alloys, Cast and Wrought. American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., 1953. 205 pages, 9 by 6 inches, paper. $3. This special compilation brings together some 50 specifications and tests covering the following subjects: aluminum and aluminum-base ingots, castings, bars, rods, wire and shapes, forgings, pipe and tubes, sheet and plate; wrought products for electrical purposes include various types of electrical conductors, and a test for resistivity; magnesium and magnesium-base ingots, castings, forgings, shapes, and so forth; general test methods for dielectric strength, tension testing, and so forth; two specifications for filler metal-electrodes and brazing material; and a recommended practice for electroplating.

AMERICAN ELECTRICIANS' HANDBOOK. By Terrell Croft and revised by Clifford C. Carr. McGraw-Hill Book Company, Inc., 330 West 42d Street, New York 36, N. Y., seventh edition, 1953. 1,773 pages, $7^1/_2$ by 5 inches, bound. $10. This comprehensive handbook, designed to meet the needs of those with little formal electrical knowledge as well as the trained electrician and engineer, provides data and instruction for the selection, installation, operation, maintenance, and proper application of electric apparatus and materials. The fundamentals of electrical theory are given as well as details of many specialized types of electric equipment. The new edition has been thoroughly revised to conform to the 1951 edition of the National Electrical Code.

APPLIED KINEMATICS. For Students and Mechanical Designers. By J. Harland Billings. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York 3, N. Y., third edition, 1953. 352 pages, $9^1/_4$ by $6^1/_4$ inches, bound. $4.50. The principles governing motion and the design of machine elements are presented; as far as possible, simple graphical methods are used. The illustrative material and problems are closely related to engineering practice. The chief elements in the revision are the addition of a new chapter on automatic control and its mechanisms and an appendix containing a group of "problems for the drafting room."

THE ATOM STORY. Being the Story of the Atom and the Human Race. By J. G. Feinberg. Philosophical Library, 15 East 40th Street, New York 16, N. Y., 1953. 243 pages, $8^3/_4$ by $5^3/_4$ inches, bound. $4.75. Written in nontechnical language for the layman, this book traces the growth of man's knowledge of the atom from Democritus to the present, giving an account of the scientists—Roentgen, Curie, Rutherford, and many others—who contributed to the understanding of the atom. The story of the co-operative development of the atomic bomb is told in detail. Two final chapters discuss present and anticipated peacetime uses of atomic energy, and the aspects, military and moral, of the use of the atomic bomb in war. Appendixes include a reprint of a United States Civil Defense Office publication, "Survival Under Atomic Attack"; definitions of detectors, accelerators, and reactors; and a brief glossary.

ELEMENTS OF ELECTRICITY. By William Timbie. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., fourth edition, 1953. 631 pages, $8^3/_4$ by $5^3/_4$ inches, bound. $5.50. In this revised edition, as in previous ones, the intent is to provide an adequate treatment of the fundamental principles which a technical student needs to know well. The electrical and magnetic data and theories are brought up to date, and the book reflects modern practice particularly in the problems which cover contemporary applications. Additions or revisions are most extensive in the field of electronics and control, particularly radar, transistors, television, ceramic capacitors, dry and gaseous rectifiers, and similar developments.

EXPERIMENTAL NUCLEAR PHYSICS. VOLUME I. Edited by E. Segré. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., 1953. 789 pages, $9^3/_8$ by $6^1/_8$ inches, bound. $14. This is the first volume of a 3-volume summary of the main results of nuclear physics research, to cover experimental techniques, significant facts and data, and the broad lines of theoretical interpretation. The five parts of the present volume, each a reasonably complete treatise on a restricted subject, deal respectively with the following topics: detection methods; passage of radiations through matter; nuclear moments and statistics; nuclear 2-body problems and elements of nuclear structure; charged particle dynamics and optics, relative isotopic abundances of the elements, and atomic masses. Extensive references to the original literature are given.

HEATING, VENTILATING, AIR CONDITIONING GUIDE. 1953. American Society of Heating and Ventilating Engineers, 62 Worth Street, New York 13, N. Y., volume 31, 1953. 1,560 pages, $9^1/_4$ by $6^1/_4$ inches, bound. $7.50. The 51 chapters of this standard reference work cover a wide range of topics: fundamentals of thermodynamics; the physiological bases of heating and air conditioning; calculation of heating and cooling loads of enclosed spaces; descriptions of systems and apparatus such as steam heating, panel heating, electric heating, refrigeration, and drying systems. It also includes instrumentation, pertinent codes and standards, a glossary of terms, and lists of abbreviations and symbols. There are detailed indexes, and the usual condensed manufacturers catalogue section is appended.

HIGH VOLTAGE A-C CIRCUIT BREAKERS. By S. Gerszonowicz. Constable and Company Ltd., London, England, 1953. 454 pages, $8^3/_4$ by 6 inches, bound. 63s. The first chapters of this book deal with basic phenomena, including overcurrents, a-c interruption, and insulation. Then follows a description of types of circuit breakers: their operation and testing; oil with plain break and controlled break; oil, water, air, and "hard gas" with porcelain insulation. Control, automatic reclosing, and testing are also discussed, and considerable space is allotted to standards. There is a closing chapter on the selection of circuit breakers. An extensive bibliography is included.

ENGINEERING DRAWING. By Frank Zozzora. McGraw-Hill Book Company, Inc., 330 West 42d Street, New York 36, N. Y., 1953. 369 pages, $11^1/_4$ by 9 inches, bound. $5. A text and reference book for the student or practicing engineer, arranged for easy progress in study, which begins with the basic elements and leads through geometrical constructions to sectioning, auxiliary views, intersections and developments, and various specialized depictions. Carefully chosen illustrations and selected problems amplify and demonstrate the text content.

GAS TURBINE ANALYSIS AND PRACTICE. By Burgess H. Jennings and Willard L. Rogers. McGraw-Hill Book Company, Inc., 330 West 42d Street, New York 36, N. Y., 1953. 487 pages, $9^1/_4$ by $6^1/_2$ inches, bound. $8.50. Written primarily for the undergraduate and graduate student, this text also presents information on gas turbine fundamentals, performance, and practices on a level suited to any reader with a good engineering background. The book begins with a discussion of fundamentals, and then applies these to specific components of the gas turbine power plant, with consideration being given to both thermodynamic aspects of design and to stresses and materials of construction. Complete air tables and combustion gas charts are provided.

PAMPHLETS

The following recently issued pamphlets may be of interest to readers of "Electrical Engineering." All inquiries should be addressed to the issuers.

Radio-Frequency Power Measurements. This circular, National Bureau of Standards Circular *536*, presents a comprehensive survey of the methods currently in use for measurements of radio-frequency power and gives a brief discussion of the theoretical background, practical limitations, and advantages of these methods. The circular contains sections on calorimetry, substitution methods, single-variable devices, 2-variable devices, and directional couplers. A comparative table and a list of references are appended. 16 pages. 15¢. Order from Government Printing Office, Washington 25, D. C.

Heat Pump Bibliography. "Bibliography of the Heat Pump Through 1951" is a comprehensive listing of about 750 references to published materials on principles, design, operation, and applications of the heat pump. Listings are divided into three sections, containing, respectively, signed articles and other publications identified by author, unsigned articles and handbooks identified by publication or publisher, and books devoted exclusively to the heat pump. 30 pages. $1.00. Order from the Edison Electric Institute, 420 Lexington Avenue, New York 17, N. Y.

Fiberglas Duct Insulations. A 16-page design data booklet for Fiberglas duct insulations has been issued by Owens-Corning Fiberglas Corporation, Toledo, Ohio. It is available upon request. The booklet has more than 40 photographs and drawings of the various rigid and flexible Fiberglas insulations for the exterior and interior of warm and cold air ducts. Included is complete information about the new flexible duct liner, recently introduced by the company. This material may be installed on metal sheets before they are bent to form ducts. It is sprayed with a light coating of neoprene to prevent erosion by high-velocity air and to reduce frictional losses.

Starter Bulletin. Allis-Chalmers size 0–3 a-c across-the-line motor starters are described in an 8-page bulletin released by the company. The bulletin covers manual and magnetic types of starters and combination and reversing starters as well as push-button control stations. Operating arrangements are described and three types of enclosures, general purpose, watertight, dusttight, hazardous dust location, hazardous gas location; and open type, are given. A table shows motor voltage and motor maximum horsepower applicable to each of the four sizes of starters described. Copies of the bulletin "Allis-Chalmers Size 0–3 Alternating Current Across-the-Line Motor Starters," *14B7132A*, are available on request from Allis-Chalmers Manufacturing Company, 931 South 70th Street, Milwaukee, Wis.

INDUSTRIAL NOTES ....

General Electric News. The Northern Commercial Company has been appointed the first agent and distributor of General Electric apparatus products in Alaska. Products to be handled include motors and controls, distribution and substation equipment, industrial heating apparatus, outdoor lighting, rectifiers, meters and instruments, fluorescent lamp ballasts, and renewal parts. Volney Richmond, Jr., president and general manager of the company, said they will provide off-the-shelf service of small electric equipment in Juneau, Ketchikan, Anchorage, Fairbanks, and Nome, Alaska, and will be backed up by Seattle, Wash., stocks of larger apparatus.

John B. Coullard has been appointed sales engineer for the Components Department. He will have the responsibility for the sale and customer application of electronic products of this department. Mr. Coullard will have his office at the LeMoyne Avenue General Electric plant in Syracuse, N. Y., where the department has set up its printed circuit production facilities.

Appointment of 3 plant managers to new positions in the manufacturing organization structure of the Lamp Division and the advancement of a plant superintendent to position of plant manager was announced. T. M. Wallace, manager of Lexington, Ky., Lamp Works, is being transferred to the Lamp Manufacturing Department at Lamp Division's Nela Park headquarters in Cleveland, Ohio. A. D. Dixon, manager of Ohio Lamp Works at Warren, Ohio, assumes the post vacated at Lexington by Mr. Wallace. T. A. Glidden, manager at Bucyrus (Ohio) fills the position vacated by Mr. Dixon. J. W. Wright, who has served as plant superintendent at Memphis, Tenn., has been named manager of the Bucyrus Lamp Works, succeeding Mr. Glidden.

Harry L. Williamson, Jr. has been appointed manager of marketing of the heat pump department. Mr. Williamson was formerly manager of advertising and sales promotion of the company's Locke Department in Baltimore, Md.

B. M. Robertson of Scarsdale, N. Y., has been named manager of finance of the company's Apparatus Sales Division in Schenectady, N. Y. Mr. Robertson has been treasurer of the International General Electric Company at New York City since 1949.

Establishment of a Direct-Current Motor and Generator Department has been announced. Oscar L. Dunn, appointed general manager of the new department which will be located in Erie, Pa., explained that it will assume all duties and responsibilities of the company's former D-C Motor and Generator Planning Study. In addition the department will have responsibility for the d-c and synchronous motor and generator lines which are now manufactured by the company's Large Motor and Generator Department at Fort Wayne, Ind., and the Medium Induction Motor Department. The following were appointed by Mr. Dunn to key posts in the new organization: Paul D. Ross, manager of marketing; Richard M. Hartigan, manager of employee relations; Paul S. Stough, manager of engineering, Louis E. Wengert, manager of finance; and Francis J. Boucher, manager of manufacturing.

Creation of 3 subdepartments within the Tube Department, and appointments of general managers for each, was announced. The Tube Department is one of 4 product divisions of the General Electric Electronics Division. Its operations encompass 8 manufacturing plants and 3 warehouses in 7 states. Named general manager of the Industrial and Transmitting Tube Subdepartment was Robert O. Bullard, Schenectady, N. Y. From his headquarters at Schenectady, Mr. Bullard will have responsibility for all engineering and manufacturing activities relating to the industrial and transmitting tube products of the Tube Department. Appointed general manager of the newly created Receiving Tube Subdepartment is L. Berkley Davis, Owensboro, Ky. His headquarters will be at Owensboro, and he will have parallel responsibilities for receiving tube operations. Named general manager of the Cathode Ray Subdepartment was Robert E. Lee, Syracuse, N. Y. His responsibility for cathode-ray tubes, whose primary use today is as television picture tubes, will correspond to that of the other new subdepartment general managers.

Westinghouse Notes. Clyde S. Gischel, formerly tire sales manager for the Firestone Tire and Rubber Company, has been appointed general manager of consumer products for the Westinghouse Electric Supply Company. He will be responsible for consumer product sales in the company's 17 districts and 112 branch offices across the country. He will report directly to Mr. Myers, president, at the firm's executive headquarters at 40 Wall Street, New York, N. Y.

A. Frye Ayers, manager of the Detroit office, was awarded the Westinghouse Order of Merit, highest honor conferred by the company upon its employees. He was honored for outstanding and inspiring service in establishing friendly relations for Westinghouse with leaders in the automotive, steel, electrical utility, and machine tool industries; and for his significant contribution to continued improvement of the company's commercial position.

The Westinghouse Electric Corporation will build a plant in Duluth, Minn., to service and repair electric equipment. The plant will be equipped to repair or rebuild any heavy electrical product, including industrial and farming electric apparatus.

The Union Switch and Signal Division of Westinghouse Air Brake Company announced the formation of a new general apparatus engineering and sales organization for the purpose of providing improved service to its many customers in aviation, electronic components and systems, traffic control, industrial electromechanical devices and related fields. Mr. Allan S.

(*Continued on page 22A*)

Superior electrical insulation AT HIGH TEMPERATURES!

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GROOVED BUSHINGS • ELEMENT SUPPORTS
TERMINAL BLOCKS • SPECIAL DESIGNS
CAN BE MADE TO YOUR SPECIFICATIONS

AlSiMag ceramic insulators retain their superior electrical insulation qualities at elevated temperatures, have excellent resistance to heat shock, permanent rigidity, high mechanical strength and low moisture absorption. Dimensional accuracy and uniformity speed assembly.

Our fast automatic production methods permit quantity production at low cost. AlSiMag insulators are well and favorably known to all testing laboratories, and help speed their approval . . . *SEND US your blue print or sample. Let us show you what we can do for you.*

FREE! Bulletin No. 344

Describing AlSiMag 197, a steatite ceramic insulation that is specifically designed for electrical appliances. Bulletin on request.

52ND YEAR OF CERAMIC LEADERSHIP

AMERICAN LAVA CORPORATION

A SUBSIDIARY OF MINNESOTA MINING AND MANUFACTURING COMPANY

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(*Continued from page 18A*)

Robertson has been appointed manager, General Apparatus Sales Department, and E. J. Agnew, manager, General Apparatus Engineering Department.

Highest Voltage Switches Built by Delta-Star. The completion of the first order for 330-kv switches ever to be placed in the United States has been announced by Delta-Star Electric Division, Chicago, Ill. These ultrahigh-voltage switches are now being installed on the transmission lines supplying the Atomic Energy Commission project near Portsmouth, Ohio. Rated at 1,600 amperes, these switches are the highest voltage switches ever built in this country.

RCA News. Election of W. Walter Watts as vice-president in charge of technical products and of Theodore A. Smith as vice-president in charge of the Engineering Products Department was announced.

A. Cameron Duncan, a veteran of 17 years in RCA Victor sales and merchandising activities, has been named manager of merchandise operations of the Home Instrument Department, RCA Victor Division, Radio Corporation of America. Joseph J. Kearney, former manager of the east central renewal sales district for the Tube Department, has been advanced to renewal sales manager for radio batteries, the post vacated by Mr. Duncan.

George E. Dittman, one of the radio industry's pioneer field sales representatives, was appointed manager of the east central renewal sales district of the Tube Department, succeeding Mr. Kearney.

C. D. Pitts, former Coast Guard officer, and well known radio and sound engineer, has been appointed a field sales representative for RCA Broadcast equipment. He will assist David Bain in the company's Washington, D. C., office.

Neal McNaughten, internationally known radio and television engineer and consultant on broadcasting problems, will join the company as administrator of the broadcast market planning section of the Engineering Products Department.

Honeywell Names Research Head. The appointment of Dr. Finn J. Larsen as director of research for Minneapolis-Honeywell Regulator Company was announced. Dr. Larsen, a member of the company's research and engineering organization since 1948, succeeds Dr. Waldo Kliever, who has resigned to accept a position with another company.

Raytheon Appointments. Three divisional appointments were announced by the Raytheon Manufacturing Company, Waltham, Mass. C. R. Hammond and O. P. Susmeyan have been named assistant vice-presidents of Raytheon's receiving tube division, and W. M. Thompson has been appointed an assistant vice-president of the power tube division.

Acme Electric Promotion. Jack Hall has been appointed director of sales of the Acme Electric lines of standard transform-

(*Continued on page 28A*)

CABLE JACKETING OF VINYLITE PLASTIC
BRAND

CORES OF BAKELITE POLYETHYLENE
TRADE-MARK

Here's a combination that gives you double assurance of long, trouble-free service life for wire and cable!

VINYLITE Brand Plastic jacketing is *really* tough—resistant to abrasion, weather, corrosive atmospheres, brine, oil and grease. Specially formulated compounds stay flexible and impact-resistant down to –67 deg. F. They're virtually good as new even after seven years' submersion in water or twelve years' burial in the ground.

BAKELITE Polyethylene has excellent electrical properties—a dielectric constant of only 2.3, a power factor only 0.0004 at 50 megacycles and 25 deg. C. It can be used in smaller diameters. Its light weight—a specific gravity of only 0.92—increases handling ease. Stripping and splicing are faster. It stays flexible down to –70 deg. C., resists deformation up to 90 deg. C. It's resistant to abrasion, aging, water, most chemicals.

All-round serviceability, light weight, easier handling—these are the outstanding features of wire and cable jacketing of VINYLITE Brand Plastic over BAKELITE Polyethylene cores. Get this team for your job—whether military or civilian. For a list of suppliers, write Dept. RJ-66.

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BAKELITE COMPANY
A Division of
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30 East 42nd Street, New York 17, N. Y.

(*Continued from page 22A*)

ers. Mr. Hall will be responsible for the further sales development of Acme Electric luminous tube transformers, fluorescent lamp ballasts, cold cathode lighting ballasts and transformers, oil burner ignition transformers, dry-type power transformers, control transformers, and the automatic voltrol and manual voltage adjustor that has been well received in the television industry.

New Plant. A new factory will be opened shortly at Warren, Ill., to expand the production of the Micro Division of Minneapolis-Honeywell Regulator Company.

RTMA Changes Name to RETMA. Members of the Radio-Television Manufacturers Association voted to change the association's name to the Radio-Electronics-Television Manufacturers Association and approved a reorganization plan which will expand the board of directors and provide larger representation for new segments of the industry, especially in the advanced electronics field. The changes become effective immediately. Two committees of the board were established. They are the Radio-Television Industry Committee and the Electronics Industry Committee. Pending the first meetings of the 2 committees of the board on September 17 in New York, Board Chairman Robert C. Strague has appointed Director F. R. Lack as temporary chairman of the Electronics Industry Committee and designated himself as temporary chairman of the Radio-Television Industry Committee.

NEW PRODUCTS • •

Lightning Arrester. A new "magnevalve" lightning arrester, featuring small size and light weight, has been announced by the General Electric Company's Transformer Department. The new arrester, to be used for the present only on 7,200- and 7,620-volt unit-type distribution transformers, has impulse characteristics similar to those of the company's pellet arresters. For 7,200-volt transformers, the 9-kv arrester is only $14^1/_4$ inches long and weighs only 10 pounds. The 10-kv arrester, for 7,620-volt transformers, is only $15^1/_2$ inches long and weighs only 11 pounds. The new arrester is now being installed on all 7,200- and 7,620-volt General Electric pole-type distribution transformers.

Double-Pole Circuit Breaker. Offering a new standard of safety for gasoline filling stations and other areas where an electric spark can cause serious conflagration, a double-pole circuit breaker which simultaneously opens both poles when one pole is overloaded has been placed on the market by Federal Electric Products Company, Newark, N. J. In some regions of the United States, the new circuit breaker has been accepted by major gasoline com-

(*Continued on page 38A*)

(*Continued from page 28A*)

panies as standard equipment in their service stations. Thermal-magnetic in action, the simultaneous-trip stab-lock double-pole circuit breaker is designed with a universal-joint-type linkage which causes both contact arms to move simultaneously to the "off" position when either one of the circuit breaker poles is tripped by an overload. The "thermal action" uses a bimetal element which permits harmless momentary current surges, as when a motor is starting, to pass without tripping the circuit breaker, but flexes and trips the circuit breaker instantly when its predetermined current-time rating is exceeded. The "magnetic action" comes into play when severe short circuits occur, giving a strong, instantaneous break in the circuit.

All-Electronic Tape Recorder. The first all-electronic, fully automatic high-fidelity music and voice tape recorders were introduced by the Ampro Corporation, Chicago, Ill. The firm, manufacturer of 16-millimeter sound motion picture projectors and tape recorders, also introduced a matching console speaker cabinet for extended range reproduction. Two models, the "Celebrity," and the "Hi-Fi," feature a new electromagnetic "piano key" control system. Solenoids operate all controls, eliminate breakdowns and wear found in ordinary mechanical linkage systems, and provide fast, simplified, foolproof recording and playback. Model *755*, the Celebrity, with a tape speed of $3^3/_4$ inches per second, has a frequency response of from 30 to 8,500 cycles per second. Playing time with dual-track operation is 2 hours. Model *756*, the Hi-Fi, has a tape speed of $7^1/_2$ inches per second, permitting maximum fidelity of the full range of audio reproduction. Frequency response is from 30 to 13,000 cycles per second. Playing time on a 17-inch reel is up to 1 hour, with dual-track operation. Both machines are the first tape recorders having complete electromagnetic, push-button operation.

Overload Radiation Switch. A new overload radiation switch that provides complete protection against tube failure due to anode overheating has been announced by Federal Telephone and Radio Corporation, associate of International Telephone and Telegraph Corporation. Designed expecially to protect radiation-cooled transmitting tubes from damage caused by excessive plate dissipation, the switch will operate with any tube whose radiant energy density at the surface is greater than 1 watt per square inch. Further information on the overload radiation switch, for which patents are pending, may be obtained by writing the Component Sales Department, Federal Telephone and Radio Corporation, 100 Kingsland Road, Clifton, N. J.

Radio-Shielding Gasket Material. A new, highly conductive gasketing material is now available for shielding radio and television equipment. It is said to be effec-

(*Continued on page 48A*)

ELECTRONIC TEST INSTRUMENTS

TEST VOLTAGE PROBLEMS 1/100 cps to 10 mc?

Hewlett-Packard has 17 different oscillator models. Some are highly specialized, others are all-purpose instruments. Almost certainly, there's a model to meet your exact requirements. All are precision instruments of highest quality. All embody the famous RC circuit pioneered by *-hp-*. Check the table below for the oscillator that can help you most. Then write us for complete operating and application details.

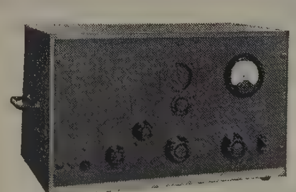
-hp- 200CD AUDIO OSCILLATOR

World standard for electronic or electrical measurements, now redesigned with wider range, lighter weight, smaller size. Use for any lab, field or production problem in sub-audio, audio, telephony, carrier, supersonic, telemetering or rf measurement fields. Highest stability, low distortion, constant output, no zero set while operating. With carrying strap for bench or portable use; or for rack mounting.

Instrument	Primary Uses	Frequency range	Output	Price
-hp- 200AB	Audio tests	20 cps to 40 kc	1 watt/24.5v	$120.00
-hp- 200CD	Audio and ultrasonic tests	5 cps to 600 kc	160 mw/20v open circuit	150.00
-hp- 200H	Carrier current, telephone tests	60 cps to 600 kc	10 mw/1v	350.00
-hp- 200I	Interpolation, frequency measurements	6 cps to 6 kc	100 mw/10v	225.00
-hp- 201B	High quality audio tests	20 cps to 20 kc	3w/42.5v	250.00
-hp- 202A	Low frequency measurements	.01 cps to 1 kc	20 mw/10v	450.00
-hp- 202B	Low frequency measurements	½ cps to 50 kc	100 mw/10v	350.00
-hp- 202D	Low frequency measurements	2 cps to 70 kc	100 mw/10v	275.00
-hp- 204A	Portable, battery operated	2 cps to 20 kc	2.5 mw/5v	175.00
-hp- 205A	High power audio tests	20 cps to 20 kc	5 watts	390.00
-hp- 205AG	High power tests, gain measurements	20 cps to 20 kc	5 watts	425.00
-hp- 205AH	High power supersonic tests	1 kc to 100 kc	5 watts	550.00
-hp- 206A	High quality, high accuracy audio tests	20 cps to 20 kc	+15 dbm	550.00
-hp- 230A	Carrier test oscillator	35 cps to 35 kc	+14 dbm/600 ohms	275.00
-hp- 233A	Carrier test oscillator	50 cps to 500 kc	3w/600 ohms	475.00
-hp- 234A	Carrier test oscillator	160 cps to 160 kc	+14 dbm/600 ohms	300.00
-hp- 650A	Wide range video tests	10 cps to 10 mc	15 mw/3v	475.00

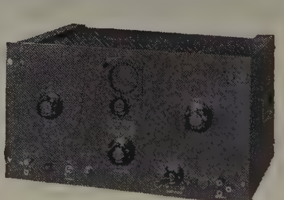
-hp- 204A Battery-Operated Oscillator

Precision instrument for measurements 2 cps to 20 kc where ac power is not available. Compact, light weight, weather-proofed—extra rugged construction for field duty. Frequencies set and read directly on large dial. Particularly useful for telephone or remote broadcast line checks, strain gauge applications, telemetering and geophysical measurements. Provides completely hum-free signal. Operates from flashlight and 45-volt batteries. Output stable and constant throughout range.



-hp- 650A Resistance-Tuned Oscillator

Highly stable, wide band (10 cps to 10 mc) oscillator particularly useful for testing television amplifiers, receiver alignment, bridge or carrier circuits, wide band systems; determining tuned circuit response. Operates independently of line or tube changes, requires no zero setting. Output flat within 1 db throughout range, monitored with VTVM. 60 db attenuator adjusts in 10 db steps.



-hp- 202A Low Frequency Function Generator

Compact, convenient, all-purpose source of transient-free voltages between 1/100 cps and 1 kc. Provides distortion-free signals for vibration studies, servo applications, medical and geophysical work and other subsonic problems. Generates sine, square or triangular waves. Output 10 v RMS, balanced or single ended, 1% distortion, constant within 0.2 db.

Data subject to change without notice. Prices f.o.b. factory

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Instruments for Complete Coverage

(Continued from page 38A)

tive even under difficult conditions of high receiver sensitivity and low signal strength. The material is made by Vulcanized Rubber and Plastics Company, Morrisville, Pa., and consists of aluminum wire screening whose interstices are filled with neoprene, the synthetic rubber made by Du Pont. The material can be supplied either in the form of cut gaskets or as uncut sheets 19 inches long and 15 inches wide. Thickness as now supplied is 0.02 inch; other thicknesses can be made if there is demand for them.

Insulating Rosin Flux. Insulation characteristics comparable to polyethylene have been successfully combined with extremely fast "take" in a newly developed rosin flux. This flux is devoid of any free acid and is completely noncorrosive. These features meet two important needs in present electronic applications: fast fluxing action and smooth, even coating necessary in the dip tinning of printed circuits; elimination of breakdown due to corrosion in the soldering of delicate ultrahigh-frequency components. Additionally, this new rosin flux is unusually resistant to high temperatures. Known as Lonco Insulating Rosin Flux and developed by the London Chemical Company, Chicago, Ill., this new flux has undergone considerable testing under actual operating conditions. For complete information write to the London Chemical Company, Inc., Department E2, 325 West 32nd Street, Chicago 16, Ill.

Transmitter Test Unit. A new television side-band response analyzer designed for use with a cathode-ray oscilloscope was announced by the Engineering Products Department, RCA Victor Division, Radio Corporation of America. The new test equipment, RCA Type *BW-5A*, measures over-all amplitude versus frequency of very-high-frequency television transmitters without using internal connections and with the transmitter operating at normal power output. The equipment includes a video sweep oscillator, and can be used in adjusting video amplifiers, modulators, and so forth, and for tuning the overcoupled broad-band radio-frequency circuits and measuring their amplitude response characteristics. Illustrated literature and specifications on the new analyzer are available on written request to the Broadcast Equipment Section, RCA Engineering Products Department, Camden 2, N. J.

Vertical Action Starter. The Square D Company will have a new NEMA Size *4* vertical action starter in production during the third quarter of 1953. With maximum polyphase ratings of 50 horsepower 220 volts, 100 horsepower 440–550 volts, the new starter is considerably smaller than the clapper-type starter it replaces. Over-all dimensions of the new open-type starter are only $9^1/_4$ inches wide, $14^3/_4$ inches high,

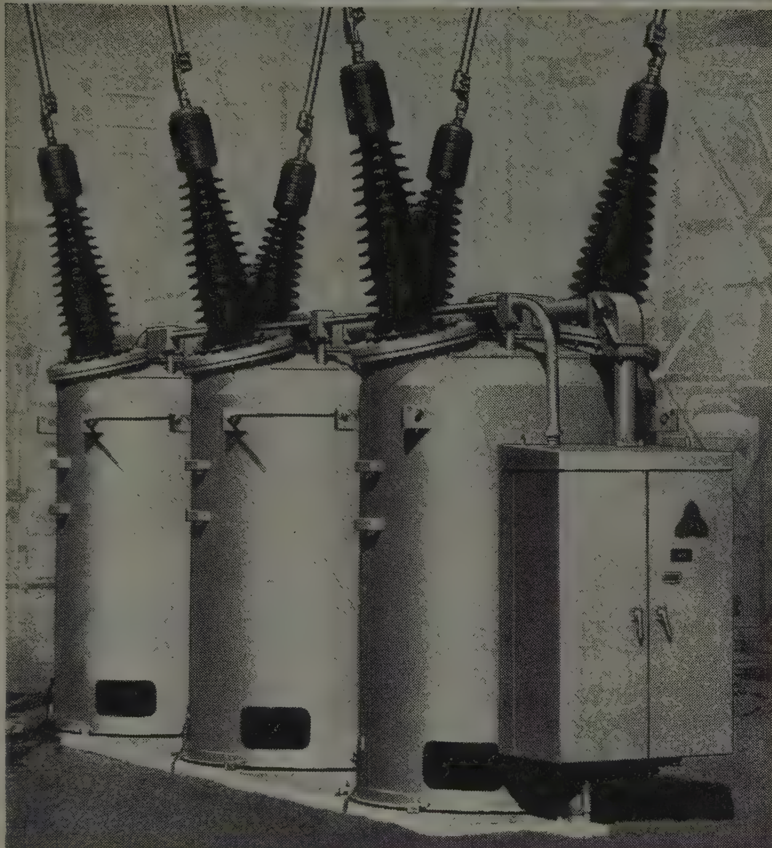
(Continued on page 58A)

Advanced Protection for Present and Future Loads

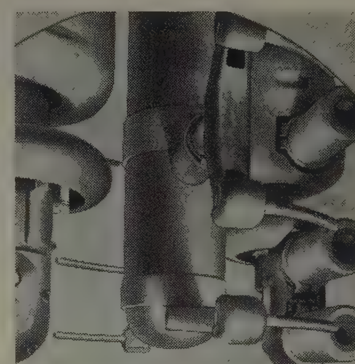
PACIFIC ELECTRIC
Type RHE
CIRCUIT BREAKERS
ASA, AIEE, and NEMA STANDARD

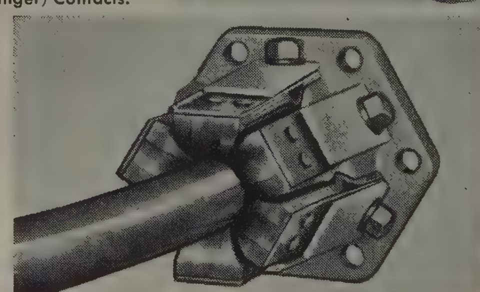
Projection of load growth and of maximum fault current may indicate the selection of breakers of far higher rating than present load requires.

115, 138, 161 kv — 3 or 5 cycles
196/230, 230, and 287 kv — 3 cycles
to 10,000,000 interrupting kva (ASA)
at 161, 230, and 287 kv



At Left: One of Fifteen Type RHE-78, 161 kv, 10,000,000 int. kva for Electric Energy, Inc., Joppa, Illinois.
At Right: Interior of Tank; a single rotary structure connects six interrupters in series (three are shown).
Below: Moving Contact Entering Nest of Six Sliding-Shoe (finger) Contacts.





These features contribute to Pacific's Proved Protective Performance . . .

Nested Sliding-Shoe Contacts

PACIFIC'S Continued use of the reliable nested sliding-shoe (finger) form of contact, even for the largest circuit breakers, is now supported by the industry trend when severe conditions are to be met.

The stationary and moving contact surfaces of the contacts are silver Elkonite, of such form that arc foot prints are confined to portions of the surfaces that do not carry load current.

The stationary contact structure of each pole comprises six sets of contacts in series, each of either four or six shoes, depending on rating. Voltage division between the sets of contacts is aided by capacitance grading shields.

Proved Interrupters

Pacific interrupters are of simple self-pressurizing type; their exceptional performance is due to improved utilization of directed oil flow and to high speed of developing open-gap distance.

Other Features

- Only one moving structure within the tank.
- Opening accelerating springs and shock absorbers are outside of the tank.
- Oil-hydraulic restoration of closing energy.
- Easy manual emergency operation for load switching as well as for test.
- Electrically and mechanically trip free in any position, even during high-speed reclosing.

Since 1906

SALES OFFICES or AGENCIES in PRINCIPAL CITIES

PACIFIC ELECTRIC MFG. CORPORATION

5815 THIRD STREET, SAN FRANCISCO 24, CALIFORNIA
OTHER FACTORIES: SANTA CLARA, CALIFORNIA; GARY, INDIANA

(*Continued from page 48A*)

$7^3/_{16}$ inches deep. Contacts used on the new device are silver which never require filling or dressing, and double-break to eliminate all flexible jumpers and pivots. The armature has straight line motion, guided at top and bottom. For copy of descriptive Bulletin *8536F*, address Square D Company, 4041 North Richards Street, Milwaukee 12, Wis.

New 60-Position Switch. The space- and weight-saving advantages of low-cost printed circuit techniques have been applied to a new 60-position rotary switch recently announced by the Shallcross Manufacturing Company, Collingdale, Pa. Stator contacts of the new switch are silver- and rhodium-plated copper printed on a paper-based phenolic deck only 3 inches square. Connections are made to stator contacts through easily soldered eyelet terminals. The combination of printed contacts and eyelet terminals makes this switch extremely light in weight considering its great number of contacts. The new Shallcross switch features an isolated shaft and is designed for 4-point spacer mounting so that a number of these single pole units may be readily ganged. Contacts are arranged to make-before-break. Detent is optional on order. Inquiries are invited regarding applications for these new switches.

Sliding Contacts. An innovation in sliding contacts or brushes for servomechanisms, radar antenna operating units, calculating machines, midget motors, and other exacting applications has been announced by the Stackpole Carbon Company, St. Marys, Pa. These Stackpole silver-graphite units feature extremely low contact resistance and great resistance to welding for maximum contact efficiency and life at minimum cost. Lowest radio noise levels, short of using more costly noble metals, are obtained by using these silver-graphite units against a silver ring. For ordinary uses however, a copper ring or commutator will suffice.

Transmitter. The Model *4* transmitter was designed primarily for use on lead-covered cable installed in ducts, but can also be used on aerial and buried cable. It has a maximum output of 15-kv direct current and a discharge capacitance of 2 microfarads. This 150-pound unit requires a source of supply of about 600 volt-amperes at 115 volts alternating current and may be used as a source of direct voltage for proof testing of cable and other insulation, a very valuable feature both at installation and after alterations or repairs. It provides a d-c over-all test facility that is particularly suited to cables and other electric apparatus in the lower voltage classes. Its maximum proof-testing capacity is 15 milliamperes at about 0.7 megohm and about 50 milliamperes at short circuit. For complete information on Biddle Impulse Cable Fault Locator equip-

(*Continued on page 60A*)

ROCKBESTOS A.V.C.® (N.E.C. TYPE AVA)

PREVENTS WIRE FAILURES... CUTS MAINTENANCE COSTS WHERE TEMPERATURES RUN HIGH

Get started on a failure-prevention campaign if you want to avoid future trouble in your power, control and lighting circuits. Look into all possible trouble-sources such as high ambient temperatures, probable overloads, exposure to moisture, oil, grease and corrosive fumes . . . then specify Rockbestos A.V.C., (AVA) the wire designed to meet these conditions.

These permanently insulated wires and cables guarantee long and trouble-free service in circuits exposed to severe operating conditions because they have an impregnated asbestos insulation that is heat and flame resistant. It won't bake brittle, crack or flow in temperatures up to 230°F . . . and won't deteriorate with age or rot when exposed to oil, grease or fumes.

Protect "hot-spot" circuits around boilers, furnaces, kilns, soaking pits, pump rooms, steam tunnels and heat-exposed ducts with Rockbestos A.V.C. (AVA). It will eliminate re-wiring jobs and expensive maintenance. 125 different standard types are available in 600 to 5000 volt ratings.

Hi ... *Your best buy*

ROCKBESTOS PRODUCTS CORPORATION
NEW HAVEN 4, CONNECTICUT
NEW YORK • CLEVELAND • DETROIT • CHICAGO
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OAKLAND, CALIFORNIA • SEATTLE

(*Continued from page 58A*)

ment write for Bulletin *65–7* to James G. Biddle Company, 1316 Arch Street, Philadelphia 7, Pa.

TRADE LITERATURE

Catalogue of Measuring Equipment. A revised edition of the General Electric Company's 64-page measuring equipment catalogue, containing information on more than 115 testing and measuring devices for laboratory and production line use, has been announced as available from the company at Schenectady 5, N. Y. The fully illustrated publication, *GEC-1016A*, contains information on products ranging from simple current indicators to completely automatic oscillographs; from surface roughness scales to mass spectrometers; from d-c amplifiers to radiation monitors.

Combustion Gas Turbines. A 24-page booklet on combustion gas turbine power plants for mechanical drive applications is available from the Westinghouse Electric Corporation. The booklet describes 4 types of combustion gas turbines manufactured by the company. Load diagrams, dimensioned outline drawings, performance curves, and colored cut-away drawings are presented for each type. Twelve factors to be considered in selecting a gas turbine power plant for mechanical drive service are listed. For a copy of this booklet, *K-5859*, write Westinghouse Electric Corporation, Box 2099, Pittsburgh 30, Pa.

Corrosion Resistance. For 27 years, continuous laboratory research and field study of the nature of corrosive attack on copper and copper alloys have been conducted by The American Brass Company's technical staff. The results of this study have recently been brought up to date in a new 28-page booklet, "Corrosion Resistance of Copper and Copper Alloys." This publication explains the chemical and physical nature of corrosive attack in its various forms. Booklet *B-36R* is available without charge from the American Brass Company, Waterbury 20, Conn.

Line and Slide Switches. A comprehensive selection of inexpensive line and slide switches for radios, television sets, appliances, small motors, toys, instruments, and similar equipment is described in a 16-page bulletin *RC-9B* available on letterhead request to Stackpole Carbon Company, St. Marys, Pa. Included are complete specifications, dimensions, and helpful application data for 7 new line switches recently developed for use with Stackpole variable composition resistors.

Hydraulic Actuator. A recently developed hydraulic actuator for Allis-Chalmers power circuit breakers, which combines advantages of pneumatic and hydraulic prin-

(*Continued on page 66A*)

(*Continued from page 60A*)

ciples, is described in a new bulletin released by the company. Identified as the "Pneu-Draulic" operator, the new actuator offers reduced maintenance, high reclosing speeds, and high system efficiency. It is conceivable, according to Allis-Chalmers engineers, that the new hydraulic actuating system may be the forerunner of a new era in circuit breaker design. It could mean the replacement of mechanical linkages with tubes carrying an operation fluid, altered physical design of present power circuit breakers, and smaller and less complete controls. Copies of the bulletin, "Pneu-Draulic" Operator, *71B7942*, are available upon request from Allis-Chalmers Manufacturing Company, 931 South 70th Street, Milwaukee, Wis.

Noise Measurement. A new publication, the "Handbook of Noise Measurement," has been made available by the General Radio Company to replace the well-known "Noise Primer." The new handbook, consisting of over 100 pages, covers thoroughly the measurement of air-borne sounds, including definitions, standards, measuring equipment, procedures, and interpretation of results. Copies of the handbook are available from the General Radio Company, 275 Massachusetts Avenue, Cambridge 39, Mass., at a price of $1.00 postpaid, cash with order.

Instruments. "Instruments for Modern Measurements" is the title of a new 34-page booklet published in two colors by Brush Electronics Company. It illustrates and describes over 37 different instruments, especially engineered and produced for: electrical measurements, physical measurements, resistance-welding measurements, textile measurements, ultrasonic energy applications, electro-acoustical measurements, and so on. Several new instruments are included as well as improved models. Booklet will be sent free of charge. Send request on your letterhead to Sales Promotion Department, Brush Electronics Company, 3405 Perkins Avenue, Cleveland 14, Ohio.

Applications of Teflon. Latest word on woven glass fabrics impregnated and coated with "Teflon," tetrafluoroethylene resin, is available in a new technical bulletin compiled by the Du Pont Fabrics Division. Not only are the outstanding electrical and mechanical properties of these fabrics, tapes and laminates set forth in tabular form, but uses in other fields are also touched upon. The chemical and solvent resistance, high and low temperature characteristics, and anti-adhesive and antifriction properties of various glass fabrics coated with "Teflon" suggest applications in the aircraft, chemical, food processing, packaging, paper, plastics, printing, rubber, textile, and other industries. Copies are available on request to Du Pont Company, Fabrics Division, Room 812, 350 Fifth Avenue, New York, N. Y.

Permutit Ion Exchangers. To summarize

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the properties of most of their ion exchangers and indicate some of their uses, a 12-page bulletin, number *2508*, has been prepared by the Permutit Company, New York 36, N. Y. The bulletin details a general history of ion exchange engineering, gives data on the proper selection of ion exchangers, and lists general applications in the treatment of water and special problems associated with the recovery of valuable metals from solutions, streptomycin purification, sugar refining, separation of rare earths, treatment of wastes, and so on.

Socket-Head Cap Screw Bulletin. The Bristol Company, Socket Screw Division, has just published a bulletin describing their line of hex socket cap screws. The new bulletin describes the features and uses of these cap screws, which are made in sizes from number 0 to 1 inch. The bulletin, Number *876*, along with an accompanying illustrated price list giving complete specifications, is available from The Bristol Company, Waterbury 20, Conn.

Aluminum Booklet. "Aluminum in Materials Handling," a reprint booklet of six articles reporting the results of a survey covering more than 50 manufacturers and users, is being offered by the Aluminum Association, 420 Lexington Avenue, New York 17, N. Y., on letterhead request.

Television Picture Tubes. A time-saving Substitution Chart for television picture tubes has been compiled by CBS-Hytron, a division of Columbia Broadcasting System, Inc., and is now available without charge from distributors, or direct from the company's main office at Danvers, Mass. The chart includes all electromagnetically deflected tubes, regardless of make. An index leads to the proper substitution group listing all readily interchangeable types.

Vacu-Break Panelboard Bulletin. Bull-Dog Electric Products Company, Detroit, Mich., has announced publication of a new illustrated bulletin dealing with its compact Vacu-Break Panelboards. Bulletin *VP-450* has 12 pages containing complete descriptive material, dimensional data, horsepower ratings, and other pertinent information. The bulletin explains the operation of the arc-snuffing vacu-break switch units and the compact $2^1/_2$-inch sliding contact unit.

Linear Actuators. Complete information on Barber-Colman Linear Actuators for aircraft application is now available in new Linear Actuator Bulletin *F 4381-1*. The bulletin emphasizes the design features, gives application information, plus specification data on these new, compact, and lightweight units which are used in remote positioning of aircraft engine controls, trim tabs, oil cooler shutters, valves, and similar functions where linear motion is is required. Address your request for a free copy to the Barber-Colman Company, Rockford, Ill.